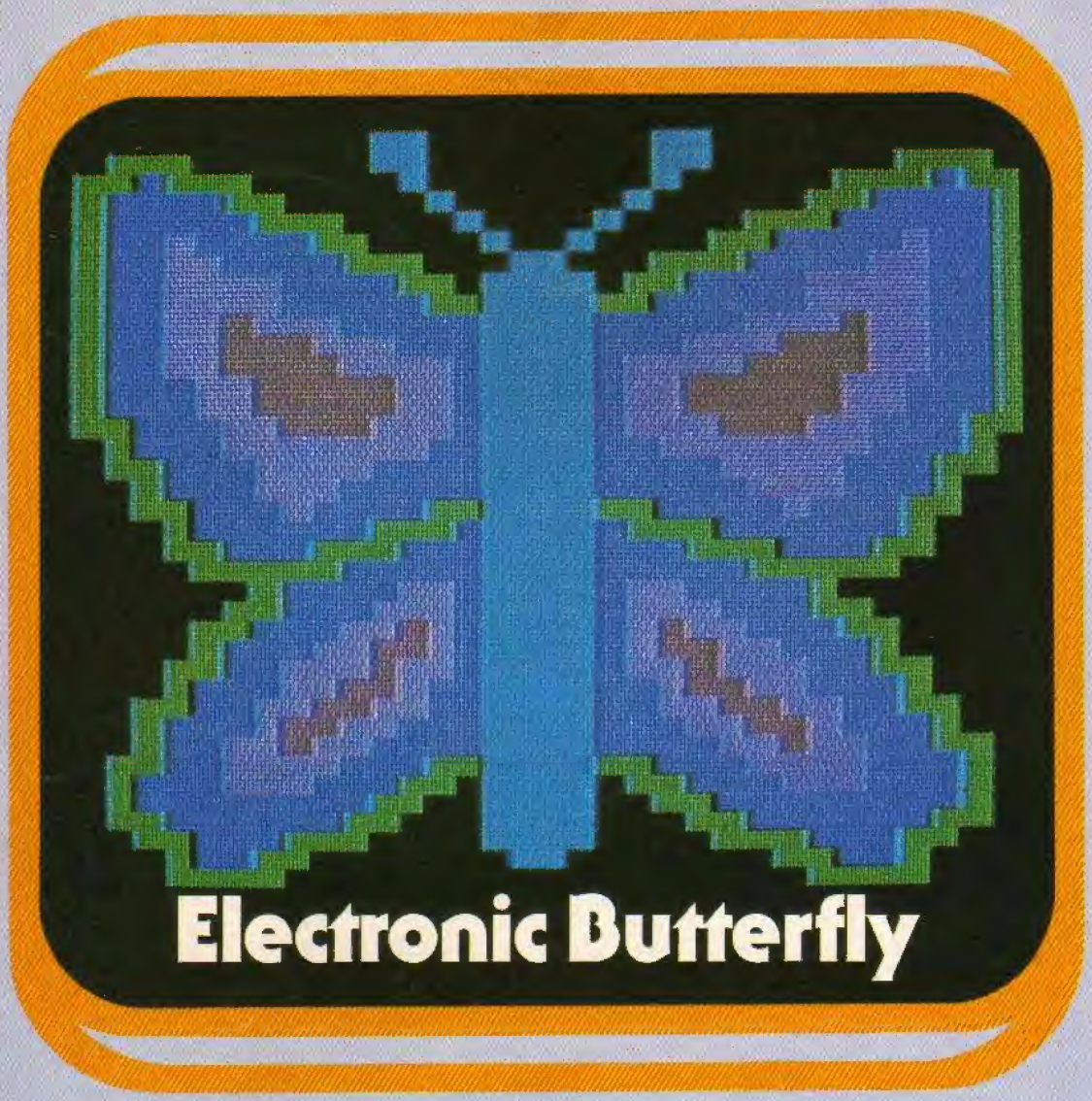
A Science Magazine from CTW, the Creators of Sesame Street. October 1982

3-2-1 CONTACT™

Special Computer Issue

Can you find your way through this maze? Answer on page 37.



Electronic Butterfly

This butterfly wasn't drawn with a pencil or a pen. It wasn't made with paint or colored pencils either. In fact, this beautiful butterfly wasn't drawn by human hands at all. It was drawn by a computer.

Of course, the computer didn't create the drawing all by itself. It was directed by an 11-year-old computer artist named Cori Grimm. Cori creates drawings like these on her own home computer. Some are even used in computer games that you may have played.

To find out more about Cori and her electronic artwork, turn to page 14.

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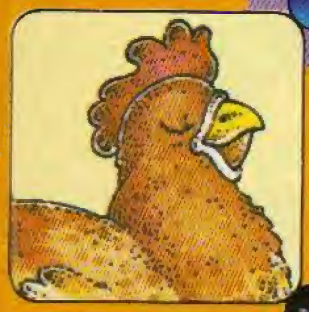

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MOVIE MAGIC FROM MAGI

by Douglas Colligan

This is Tron, the mighty movie warrior.

Did you ever wonder what it might be like to live inside a video game? Imagine walking around in a world of flashing lights and strange electronic creatures. In the Walt Disney movie called TRON, that's just what happens. The hero finds himself living in a video game world.

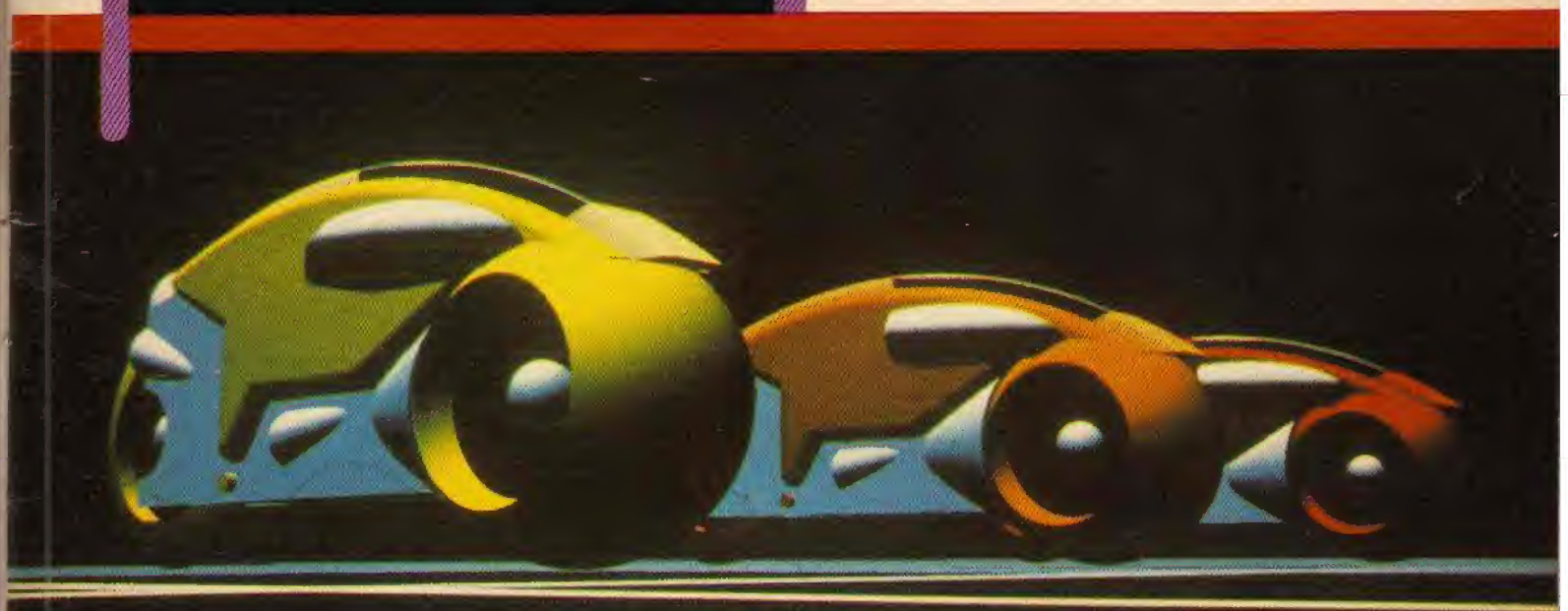
The hero is a young computer genius named Flynn. His troubles start when he first suspects that a company has stolen some of his video game ideas. Flynn tries to find out what information is stored in the company's computer. But he finds big trouble instead. A special ray absorbs his body and sends him into the video game world.

In this strange land, Flynn meets an odd assortment of weird creatures. There is a powerful villain who tries to destroy him. And, of course, this villain has some horrible helpers. These giant flying robots swoop out of the air and try to nab Flynn.

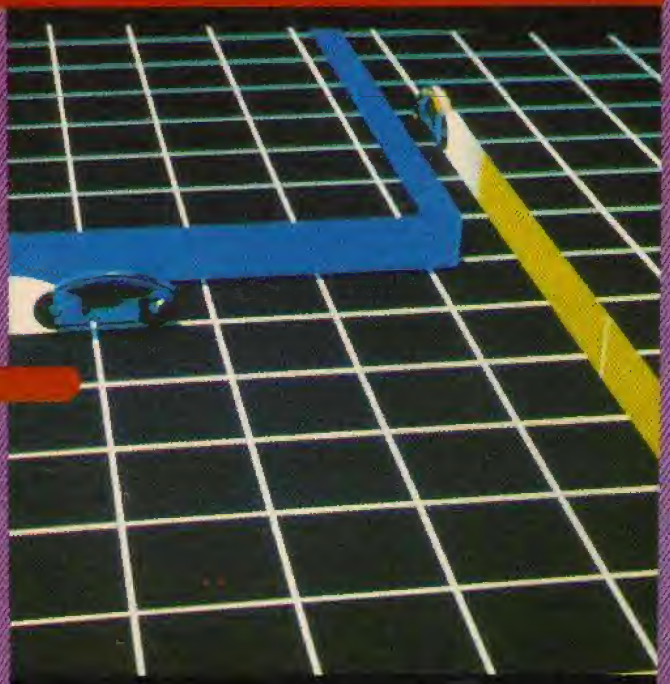
Behind the Scenes

Actually, rays that blast people into another world don't exist. Just the thought of getting trapped inside a video game is too fantastic for most people to consider. But not for Larry Elin. He works at MAGI (MAJ-eye). That's one of four companies that produced the exciting video scenes in TRON.

Larry is an *animator*. He drew many of the



The colorful light cycles you see in TRON were created on a computer.



Left: The inside of a tank looks like this in TRON's video game world. The man is standing at the controls.
Above: Light cycles race on an electronic grid. As they zip along, they create walls of light behind them.

exciting pictures you see in TRON. To do his work, Larry used computers and beams of light. That's part of what made TRON so special. "It was the first movie to make major use of computer animation," he says.

Computers make the work of animators like Larry much easier than it once was. Years ago, animators had to make a separate drawing for every tiny movement a cartoon character made. Just to show someone taking a step required dozens of drawings. Each showed a slightly different picture. Every drawing would be photographed on a separate bit of movie film. When all these different bits were put together, it looked like a character was really walking.

MAGI Movie Making

At MAGI, computers now help the animators with the hard work of doing all that drawing. Here is how they were used to create the animated video game world you see in TRON. "First, we sat down with an animator from Disney," says Larry. "He gave us a rough idea of what each scene should look like. Then we fine tuned his basic ideas along with him." The people at MAGI also received *storyboards*. These short cartoon strips showed what was supposed to happen in each movie scene.

Larry and the other specially trained artists at MAGI are called *encoders*. They started with pictures of futuristic motorcycles and flying ➳

This warrior is holding up an identity disk. It is used for many things, including fighting.

robots that had been drawn by people. Then they sat down at computers and pressed keys to describe the drawings to the machine. To do this, they had to use a special code of letters and numbers.

Using this system, the encoders told the computer what a particular robot or motorcycle looked like. They could describe an object's size, its color, what direction it was moving and how fast. Using tiny dots of light, the computer could then draw the actual picture or scene that the encoders wanted.

Catching the Glitches

Once the MAGI people finished a movie scene, they directed their computer to play it out on a large screen. The Disney movie makers in California were eager to see how each part of TRON was going to look. So a computer hookup let them preview each scene right on their own computer screen 3,000 miles away!

Then the mistakes, sometimes called "glitches," were found and corrected. If a character had a misplaced spot of light on his face, it was removed. This computer link made it possible for the MAGI artists to finish each scene two to five days quicker than usual.

Last of all, the MAGI people used a second, more complicated computer to do a final finished drawing. Along with a special movie camera, this computer drew and photographed scenes overnight that would have taken human animators a week or more to do.

TRON 2?

Doing this computer animation work for TRON was exciting for Larry. He and the other MAGI artists learned a lot that will make future computer-made movies more realistic than ever.

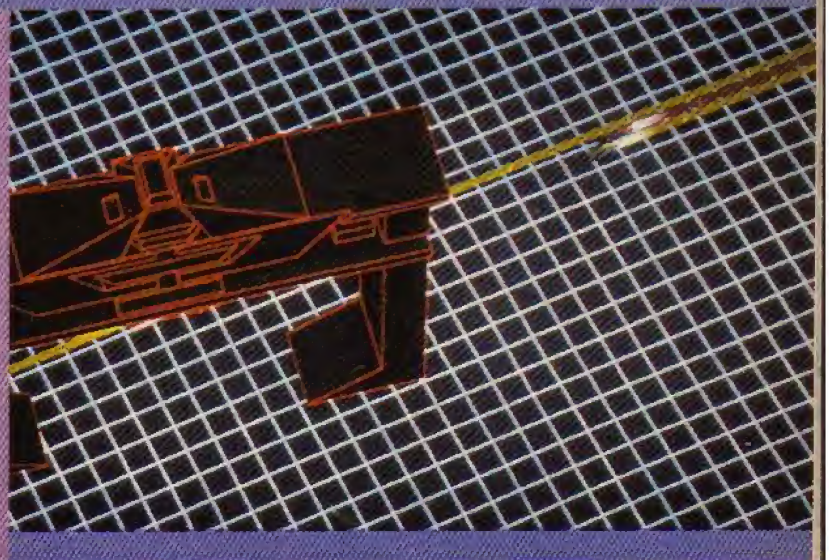
Take the TRON scene where motorcycles made of light race around on a grid, for example. "The computer can easily draw a grid. But there's one problem with it," says Larry. "The farther away the grid is, the brighter it gets. But you know that objects that are far away actually look dimmer."

So Larry had to learn how to make the computer-drawn grid look dimmer in the distance. He also figured out how to make the computer-drawn objects cast shadows, just as objects do in the real world.

Larry predicts that you will see even fancier computer animation in future movies than you see in TRON. What exactly does he have in mind? Maybe you won't find out for sure until you see a sequel to TRON. The MAGI animator had such a good time working on this movie that he's already hoping there will be a TRON 2.

Above: This MAGI artist worked at his computer to create a tank for the movie. First, he pressed buttons at the keyboard to give directions. That produced an image of a tank just the size and color he wanted. Then he took a close-up look to make sure the tank was perfect.

This is how the tank appears on the screen when you see it in the movie.



Above: This strange-looking robot swoops down and tries to capture a light cycle.

Factoids

Each hair on your head remains there for up to six years. Then it falls out and is replaced by a new one.

On the average, a typical egg-laying hen produces 227 eggs a year.

The smallest breed of horse is the Fallabella. A full-grown Fallabella is only 32 inches tall.

There is enough water in the Great Lakes to cover the U.S. with 12 feet of water.

Before erasers were invented, people tried to rub out their mistakes using pieces of bread.

In 1976, Mary Jane Freeze, age 8, spun her hula hoop non-stop for 10 hours, 47 minutes—a record!

The average American munches about 17 pounds of candy every year.

The Bloodhound Gang

The Case of the Flaming Feather

Part Three

by Madeline Sunshine

The Bloodhound Gang was in a tight spot. Vikki, Zack and Ricardo were hiding inside the houseboat of Robert Maxwell, whom they suspected had set fire to the Flaming Feather Discotheque. Maxwell was on deck, demanding that they come out with their hands up.

The Bloodhound Gang stood quietly on the boat for a moment. Finally, Vikki spoke up. "Don't shoot, Mr. Maxwell," she said. "We're unarmed."

The three young detectives slowly walked outside.

"You're just kids!" exclaimed Maxwell.

"And you don't have a gun!" Zack replied.

"A gun? Why would I have a gun? Oh, you mean the hands up stuff. I thought you were robbing the place. I was afraid you had guns."

"Us?" said Ricardo. "That's ridiculous!"

"Not from my point of view," Maxwell said. "Some old man tells me that two guys and a girl sneaked onto my boat, and I'm not supposed to be afraid? Be serious!"

"We are serious," said Vikki. "And we're also here with a reason." She explained about the fire at the Flaming Feather. Then she said, "You can't deny that you have both the motive and the weapon we suspect was used—a flare gun."

"Guilty on both counts," said Maxwell. "But not guilty of arson. Adam Silver was wrong to give me the sack. He listened to some rowdy customers, but he never asked for my side of the story. As to the flare gun—come on, I'll show it to you. It hasn't been fired for years."

The Bloodhound Gang followed Maxwell down to the cabin and examined his flare gun. It was dusty, rusty and obviously unused.

"We owe you an apology," said Vikki.

Maxwell shrugged. "You're not alone," he said. "A lot of people have been jumping to the wrong conclusions about me lately."

"Well, I guess we'll be going," said Zack. "That is, unless you have any information that might be helpful to us."

"What? Me help Silver?" said the man. Then he

stopped himself. "Hold on. I'll make you a deal. I do know something that might put you on the right track. But I want something in return."

"What?" asked Ricardo.

"I want Silver to hear me out . . . give me another chance."

"Done!" said Vikki. Zack and Ricardo looked at her questioningly, but she silenced them with a glance. "What can you tell us?" she asked.

"I'm not naming names," Maxwell began. "That's not my style. But keep in mind that richer people than I have boats, flare guns and motives. People who have their own plans for a building like that."

A New Suspect!

"Of course!" said Zack. "Silver was just leasing the place. It's got to be the landlord. What was his name? Bennett?"

"Good night," said Mr. Maxwell, quickly ending their interview. "I trust you'll keep your end of the bargain."

"Good night," said Vikki, Ricardo and Zack as they left the boat.

The next morning, the three detectives were up at dawn. Unable to reach Marshall Brady by phone, they set out for the Marina by themselves, hoping to locate Frank Bennett's boat.

The Bennett boat turned out to be a 35-foot yacht.

"Good morning," Vikki said to a youngish man who was busily painting the vessel a bright shade of green. "Is Mr. Frank Bennett on board?"

"I'm Frank Bennett," said the man. He wiped his paint-covered hands on a rag soaked in turpentine. "Is there something I can do for you?"

"I, uh, hope so," said Vikki, trying to improvise as she went along. "See, we're doing a story on boats and boat safety for our school newspaper. We figured maybe you could help us out."

Once Bennett agreed, Zack, Vikki and Ricardo quickly made up a few easy questions to ask. Then Zack sprang the big one. "We've heard that all boats are equipped with flare guns," he said. "Could you show us how one works?"

"What does that have to do with anything?" the man asked, immediately on guard.

"It is a safety device," said Vikki. "So it's part of our research."

"I'm afraid mine is, uh, out of commission," the man said. "Why don't you ask one of the other boat owners?"

"Because yours is the one we want to see," said Zack. "That is, unless you left it at the Flaming Feather last night."

"What!" said the man, surprised by Zack's statement.

"Sure," said Zack. "We were at the masquerade ball, too. We saw you there."

"But you couldn't have," the man stammered, almost unaware of what he was saying. "My Darth Vader costume covered. . . . "

Vikki, Ricardo and Zack exchanged a knowing glance.

"You almost killed a lot of people," said Ricardo. "You know that, don't you?"

"Oh yeah? Well, it doesn't matter, 'cause you can't prove a thing," Bennett shouted. "Now get out of here. Get out before I lose my temper!"

The Gang Keeps Watch

The Bloodhound Gang pretended to leave the area. But they quickly doubled back. They hid behind a building and waited and watched. Within minutes, Bennett tossed a plastic bag into the bay. Then he and his boat took off.

"Not very clever of him," said Ricardo as, fully clothed, he dove into the water to retrieve what the man had discarded.

When he returned, sopping wet, they carefully examined the contents of the bag, making sure not to leave their own fingerprints on the evidence. Inside, they saw one Darth Vader costume and one flare gun about the size of a plastic water pistol.

A few hours later, after Ricardo had changed into dry clothes, the three detectives entered the fire marshall's office.

"Well, that's quite a morning's worth of work," Brady said as he looked over the new evidence. "These should be loaded with Bennett's fingerprints."

"Bennett must have known that Silver's business wasn't insured," said Vikki. "Once it was burned, there was no way the Flaming Feather would be rebuilt."

"I think you're right," Brady agreed. "My guess is that when Bennett lost the court battle to evict Silver, he decided to wage a real war! What he doesn't know is that if we convict him, Silver can sue for enough money to build five discotheques." He picked up the phone and ordered his men to

watch the dock and wait for Bennett's boat to return.

"Good thing most of the decorations in the disco were flame-resistant," Zack said, thinking back to the night before. "Otherwise, the fire could have been much worse."

"Flame-resistant doesn't mean fireproof," the marshall said. "It just means that it will take five to ten seconds longer before the material reaches its kindling point and actually ignites."

"Kindling point?" said Ricardo.

"That's the temperature at which something burns," Zack said.

"Right," said Brady. "Let me add that the heat from a flare reaches 900 to 1,000 degrees, which is way beyond the kindling point of cloth drapes."

"But Bruce said the drapes caught fire *as soon as he saw the flash*," Ricardo pointed out. "According to what you just told us, flame-resistant material would take five to ten seconds to ignite."

"Maybe Bruce exaggerated," said the marshall.

"Or maybe there was another chemical present," said Vikki, "like turpentine."

"Why turpentine?" said Brady.

"Bennett was painting his boat this morning, and there was a can of turpentine in plain view," Vikki explained. "He even cleaned his hands with it."

Checking Out a New Clue

Brady called the lab. "Put a piece of that drape into the gas chromatograph," he told the lab analyst. "We're specifically looking for turpentine or any other form of paint thinner."

"What's a chromatograph?" Zack asked, always curious about scientific gadgets.

"It's an instrument used specially to identify chemicals made with oil," Brady said. "It has a chamber into which we'll put a piece of the drape. Then the machine will analyze the drape and project a pattern of electrical impulses in the form of lines onto a graph. Now, every chemical element shows up differently on the graph. Some form high peaks; others form lower peaks. By matching the graph produced when we study the piece of drape against sample graphs from our files, we'll find out whether an oil-based chemical was used; and if so, which one."

"That's terrific," Zack exclaimed. "It's really ter—"

But the marshall's phone rang before Zack could complete his sentence.

"Terrific!" Brady said, taking the word right out of Zack's mouth. "Bring him down right now. Well, my friends," he said. "It seems Mr. Bennett has confessed. Unsuspecting, he pulled into the Marina about 10 minutes ago, and the police were waiting for him. Bennett even admitted his motive. He had plans for a high-rise apartment building on the site of the Flaming Feather."

With the case closed, and commendations from Brady in hand, the Bloodhound Gang still had a few loose ends to tie up before they could head for home.

The next night at a tenants' meeting called by Mr. Silver, everything was worked out. Silver promised that when he rebuilt the discotheque he'd make sure the materials used were soundproof, as well as fireproof. That way, the club's neighbors wouldn't be bothered by the noise. He also agreed to rehire Robert Maxwell, who, as manager, would keep the disco's customers in the disco and not on the streets.

"One more thing," said Silver with a smile. "When I reopen, I propose to rename the club The Blazing Bloodhound."

"I think you'd do better to find a name that has nothing to do with fire," Vikki laughed.

Everyone joined in, and soon the meeting turned into a celebration.

Next month begins the exciting Case of Trouble in Paradise!

Computer Code

Believe it or not, a computer can only understand two things—the numbers 1 and 0. Every instruction a computer receives is translated into a code using just those two numbers. It's called a *binary code*. Computers use this code as a simple way to read information that is fed into them.

Can you translate the answer to the riddle? Use the simple binary code you see here.

What do you have to know to teach a dog tricks?

Answer: 01101 01111 11101 00101
11011 01000 00001 01110
11011 01000 00101
00100 01111 00111

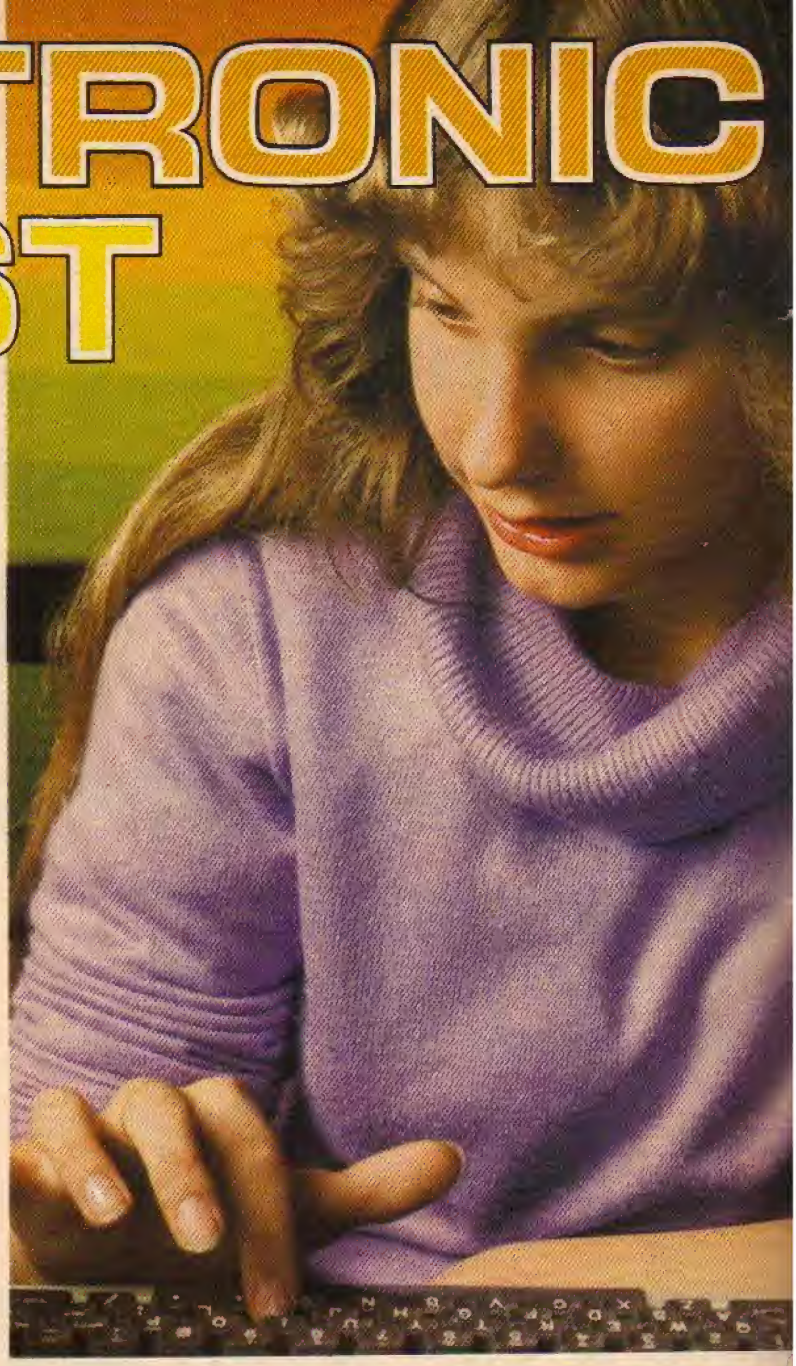
Write your answer in the spaces here.

A	00001	N	01110
B	00010	O	01111
C	00011	P	10000
D	00100	Q	11110
E	00101	R	11101
F	00110	S	11100
G	00111	T	11011
H	01000	U	11010
I	01001	V	11001
J	01010	W	11000
K	01011	X	10111
L	01100	Y	10110
M	01101	Z	10101

Answer on page 37.

ELECTRONIC ARTIST

MEET A GIRL WHO DESIGNS COMPUTER GRAPHICS



by Carol Dilfer

Cori Grimm frowns a little as she concentrates. She is hard at work creating a dragon. She gazes intently at what looks like a normal TV screen. Then she turns the knob on a box in her hand. A gray square moves across the TV screen.

Soon this square is just where Cori wants it to be. "There!" she exclaims, pressing a key on what looks like a typewriter. A green dot replaces the gray square. When Cori turns the knob, a trail of green flashes across the TV screen. Now the dragon's tail she's making is complete.

Cori is using a computer, instead of pencils and brushes, to create pictures. This dragon is the latest of many computer pictures she has made. The pictures are called *graphics*.

For Cori, creating graphics is more than a hobby. It is work that she gets paid for doing. Already her graphics appear in more than 30 computer programs developed by The Learning Company.

You might see some of her pictures yourself if you play educational computer games such as Moptown or Magic Spells. Cori's graphics are fun and exciting. They include dancing skeletons and sparkling rainbows, friendly monsters and a unicorn.

More Than a Toy

Cori has been making computer graphics for two years now. At the age of eleven, she is one of the youngest among the many computer graphics artists in the U.S. She first got interested when her family got a small home computer just for fun. She learned to use it by playing games like Space Invaders.

Soon Cori's family received a new computer *program* as a gift. A program is a list of commands you use to tell a computer what to do. This program made it possible for someone to create art work on a computer. Cori began getting new ideas about how to use her computer.

"I just started playing with the new program," she says. "It was easy to use, and I loved making graphics. So I just kept going. Now I've made more than 400 graphics."

Cori has often dabbled with art work before. But she never thought of herself as being good at drawing. "I can't seem to make things look like I want them to look," she explains. "The paper gets messy because I erase everything."

But the computer makes it much easier for Cori to create a picture. "You can erase and

redraw until you have just what you want," she says. "You can also change colors easily. Say you draw pink flowers, but want orange instead. Just press a key, and bingo—orange flowers."

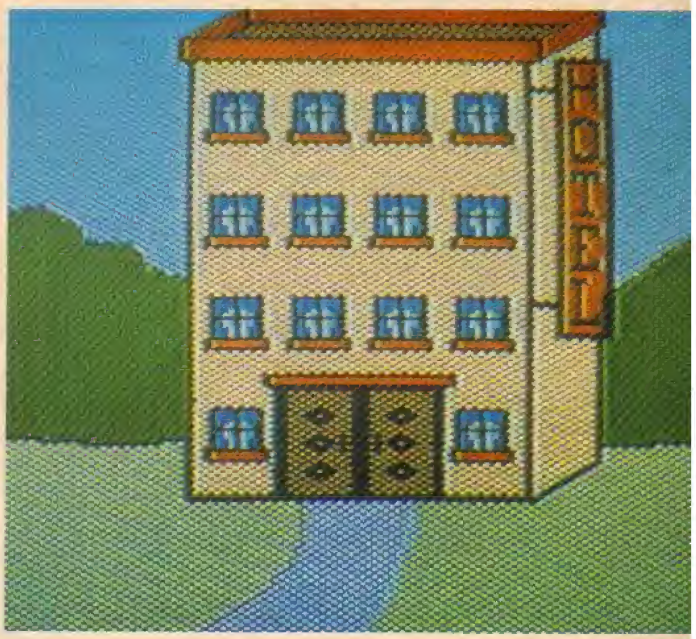
How to Make a Dragon

Cori usually takes from two to eight hours to create a new graphic. Working right at the computer, she produces pictures on the screen. She starts to work on her dragon again to show exactly how she creates a graphic. "This thing that looks like a typewriter is the computer. The keys I press are part of its keyboard," she says. "And that box with the knob is called a paddle. It moves the flashing gray square on the screen."

For this picture, Cori is using the computer graphics program called Color Sketch. It contains 16 different colors. Color Sketch divides the screen into invisible rectangles. "To tell the computer what colors I want and where to put them, I use the paddle and keyboard," she explains. Cori fills in more rectangles with color.

By adding more colored dots to the dots she's already put down, Cori slowly builds up her picture of the friendly dragon. "This work takes a lot of patience!" she says.

Cori usually draws her ideas right on the computer. But sometimes she can't make the picture she's creating match the one she sees in her mind. Then she calls on her family for help. That's when her mother, Leslie, will sketch ➡



Left: Cori Grimm looks like she's typing here. But she's really working at her family's home computer. She uses it to create art designs called graphics.

Above: This friendly unicorn and the hotel are examples of the art work Cori creates on her computer. The hotel took her eight hours to complete. **Left:** Sometimes Cori helps her friends learn to use the computer. Here she shows Christopher Tin how he can make computer designs, too. On the screen in the background, you'll see a skeleton.

something for her to look at. At other times, her sister, Cindy, will make good suggestions.

"Once I was working on a creature called a Gribbit and couldn't get the head right," remembers Cori. "Cindy told me that two more rectangles of color would help." Cindy was right. The Gribbit looked much better.

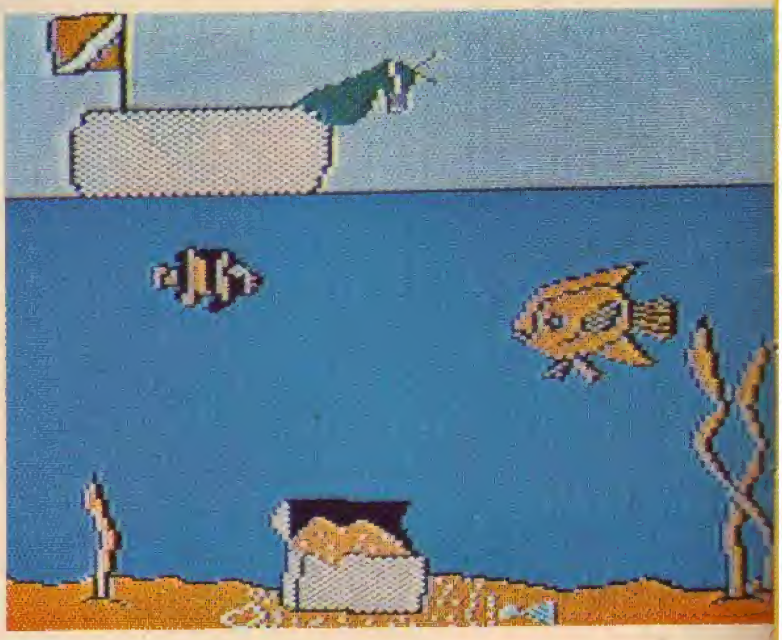
Work and Play

Cori's programs are used to help kids learn reading, math and logic. Cori and her mother often work for The Learning Company as a team. First, Leslie designs the learning programs. Then Cori creates the graphics to go with them.

Of course, Cori enjoys earning money for her art work. Some of her earnings will be saved for college. But she also gives in sometimes to the temptation to go shopping. She buys a lot of records since she likes rock music.

The young artist does her computer graphics work only on weekends. For the rest of the week, her life is much like that of other kids. "During the week, I go to school, do homework and play with my friends," she says.

And when her friends come over to visit, they sometimes gather around the computer. But they're not there to watch Cori make graphics. Instead they've come to have fun. You see, this young artist still loves to play computer games.



Above: Some of Cori's computer graphics are very colorful. These scenes are also full of interesting details.
Left: Cori's friend Heather helps her work on the idea for a new graphic design. Cori also gets ideas for her work from her family.

Experiment

Hidden Color

This month's *Earth Works* tells about the hidden colors inside a green leaf. Usually you see these colors in the fall. But here's a way they can appear any time of year.

What You Need

a large spinach leaf
rubbing alcohol
2 glass jars
an old spoon
a toothpick
a white paper towel
a pencil
tape
scissors

What You Do

1. Break spinach leaf into small pieces. Place in jar and mash well with spoon.

2. Add one half teaspoon of rubbing alcohol to the leaves. (Warning! Rubbing alcohol should be used carefully. You might want to ask an adult for help.) Mash more. You should soon have dark green liquid.

3. Cut a strip from the paper towel.

4. Dip the toothpick into the green liquid. Make a dot one half inch from the bottom of the paper strip. Let it dry and repeat about 25 times until dot is *dark* green. The darker the dot the better this experiment works.

5. Pour alcohol into the second jar until it is one half inch high.

6. Tape the top end of the paper strip to the pencil.

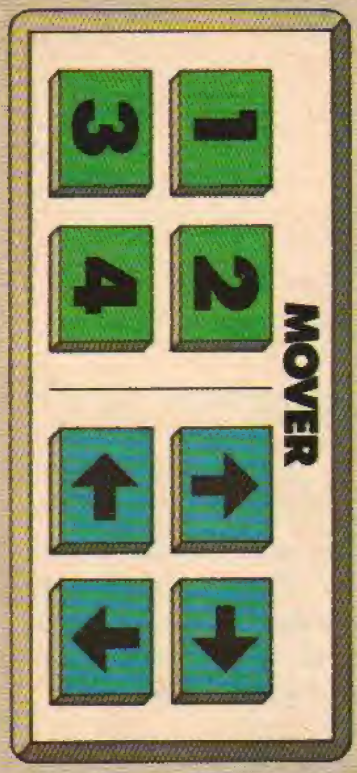
7. Place the pencil across the top of a jar so the strip hangs down. The end with the green dot should dip slightly into the alcohol.

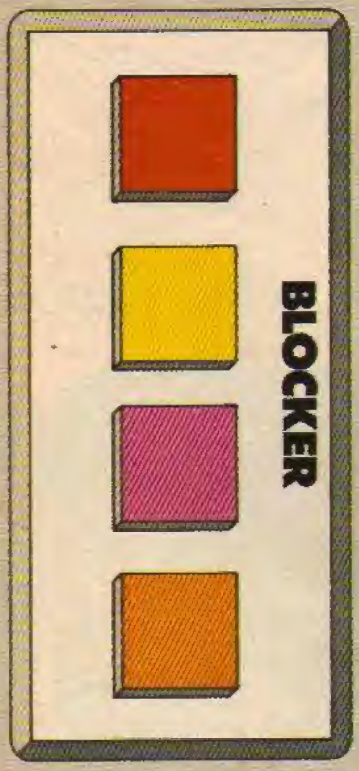
The paper will soak up the rubbing alcohol. As the liquid moves to the top of the strip, you should see a streak of green and yellow.

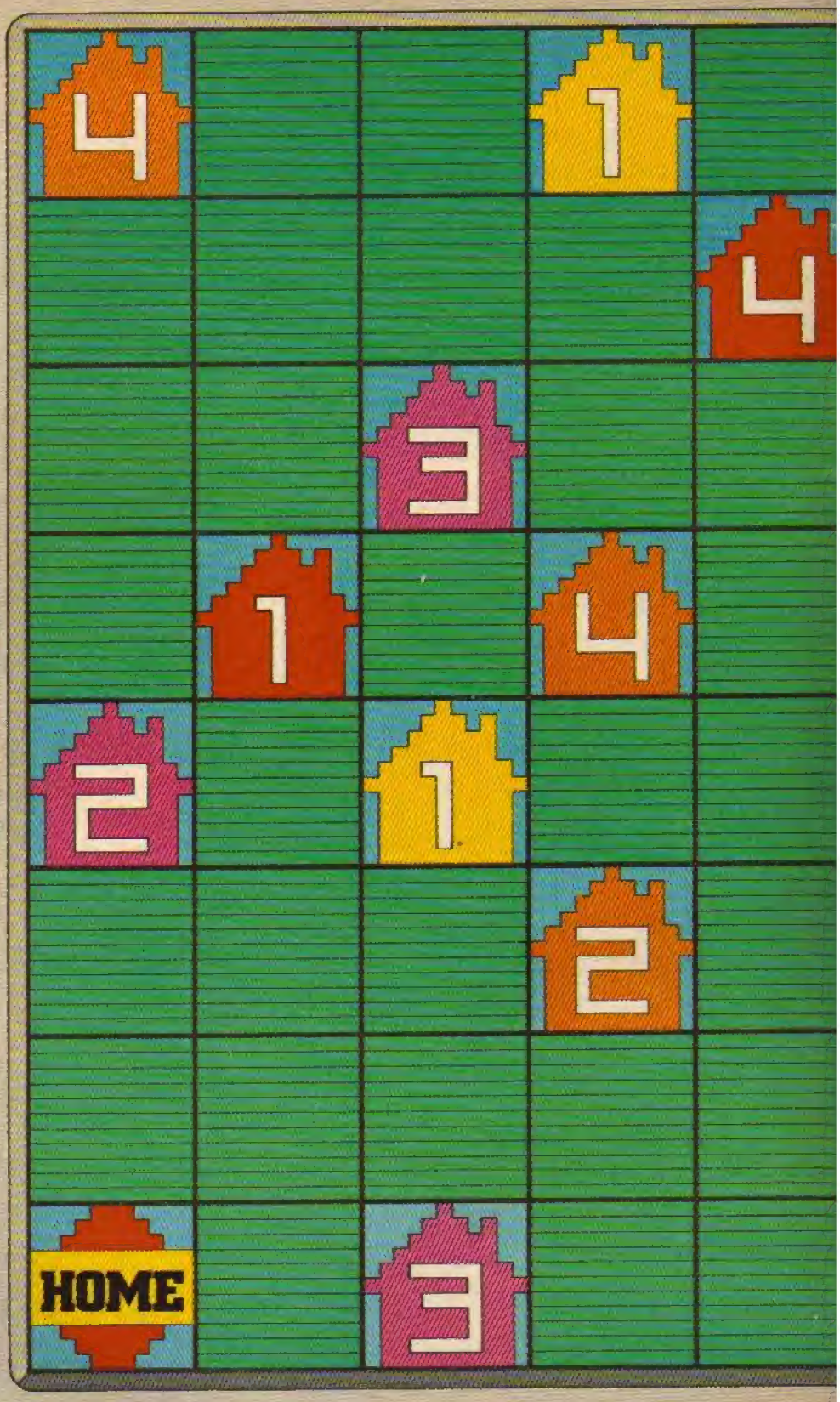
Why It Works

The green you see is *chlorophyll* (KLOR-uh-fill). The yellow is another substance called *xanthophyll* (ZAN-thuh-fill). The green liquid you mashed out of the spinach leaf and put on the paper towel has both of these substances in it. As each dissolves in alcohol, it is carried up the paper towel. Since the two dissolve separately, you can see both colors.

In the autumn, chlorophyll in the leaves breaks down and disappears. This allows the yellows and oranges to shine through. Then, when the reds and purples form, you can see all the beautiful fall colors.







GRAB BAG

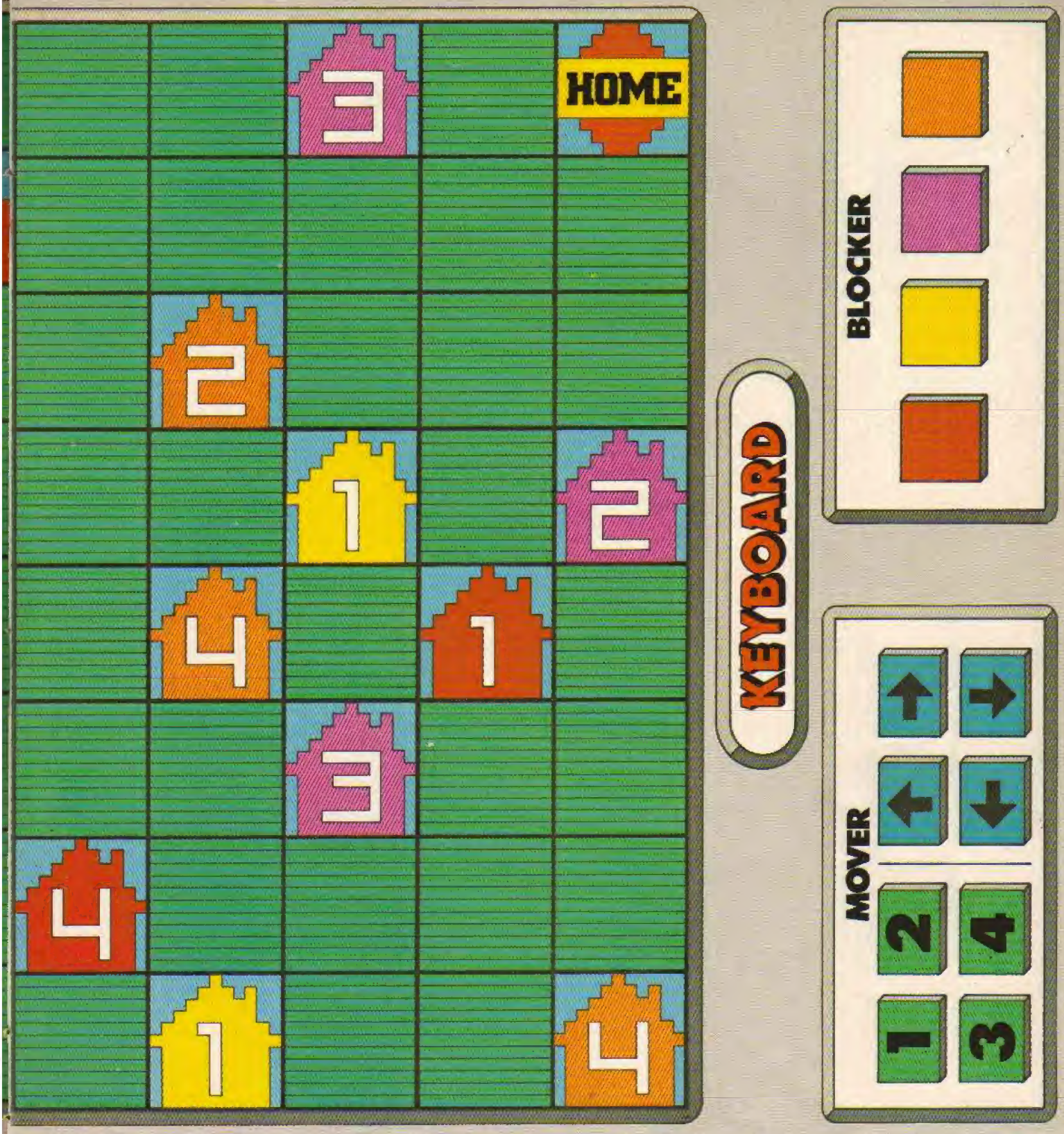
In this computer-style game, you get a chance to go trick or treating. As you move from house to house, you will collect bags of candy. But be careful! Your opponent will be trying to capture your bags.

Setting Up the Game

1. Each player sits on one side of the game. In front of you is your keyboard.
2. Place a coin or button on the space marked "HOME" nearest to you.
3. Choose to see who is MOVER first. The other player is BLOCKER.

Moving and Blocking

1. Cover your keyboard with your hand, so that your opponent cannot



see what you are about to do. At the same time, your opponent hides her keyboard from you.

2. With his other hand, MOVER points to one arrow and the number of his choice.

3. At the same time, BLOCKER points to a color square hidden on her keyboard.

4. Take away the hands that are hiding the moves. MOVER now moves his piece the number of spaces in the direction of the arrow he picked.

Collecting the Bags

1. When you land on a house, it is time to collect the number of bags inside. If BLOCKER has picked the color of the house correctly, she gets the bags. If not, MOVER gets them.

2. Take turns being the MOVER and being the BLOCKER.
Keep score on a separate piece of paper.

3. When you have collected 21 bags, it is time to head for home.
But you must go *to the other person's home base*. The player who first collects 21 bags and reaches his opponent's home base is the winner.


321 CONTACT
POSTER


These toothy creatures were sent to us by our readers.
Thanks!

ELECTRONICS

by Michele Lyons

Computers are everywhere. Even computers that you never see are often helping you in some way. They now create some of the exciting images you see on a movie screen. Other computers guide the large roller coasters you love at amusement parks.

Computers are very useful machines. They store a huge amount of information and recall it quickly. That saves valuable time. Computers are handy for another reason. They store information so that it can be kept and used forever. And, when you consider how much information they hold, they hardly take up any room at all.

No doubt about it, computers help people a lot. Some help doctors find out what causes people to get sick. Others simulate or copy the experience of flying a plane so future pilots can get trained. Want to know more about new uses for computers?

Sports Computer

Al Oerter is an Olympic champion. His specialty is throwing the discus. In four straight Olympics he hurled this heavy metal disk far enough to win the gold medal. Al hopes to compete in future Olympics, too. With this in mind he went to a sports computer for help.

Above: Al Oerter threw a discus farther after getting help from a computer at a sports center.
Left: Dr. Gideon Ariel watches a stick figure on his computer screen. It is an animated representation of Jimmy Connors' tennis swing. Dr. Ariel runs two computer centers to help athletes.

IN ACTION

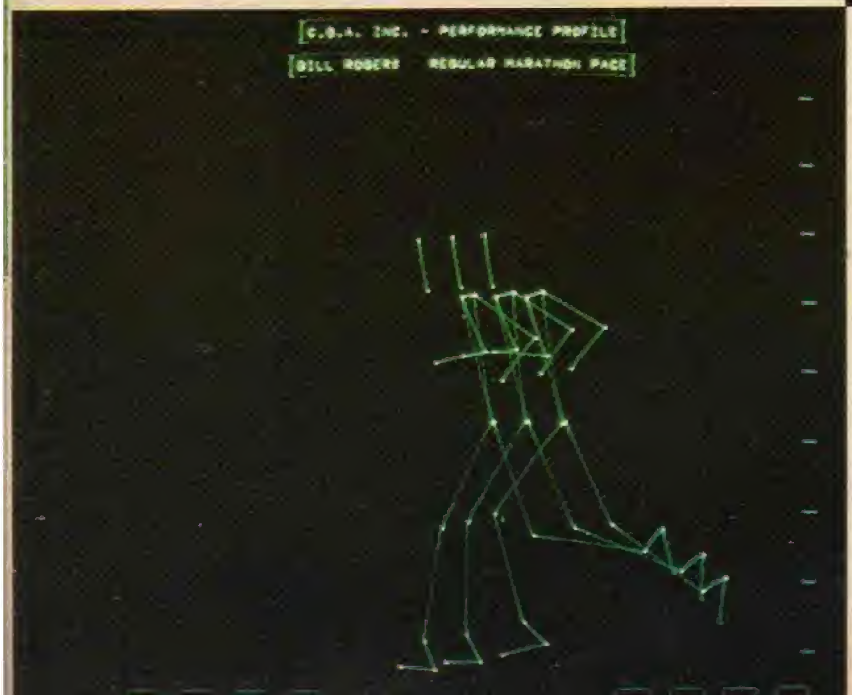
NEW USES FOR COMPUTERS

Sports researchers are using computers to help all kinds of athletes improve their performance. At the Coto Research Center in California, swimmers, runners, divers and other sports champions all come for help. It all starts when trained technicians make a movie of a particular athlete in action. Then they play the film in super slow motion on a special screen. The screen is divided into thousands of numbered squares. Using a special wand, the technicians touch every square. That gives the computer information about how an athlete moves.

The computer matches parts of the person's body with the numbered squares, then it stores this information. Later an athlete, with the help of a technician, asks the computer specific questions about how he or she is performing. Using all the information it has collected, plus some basic rules about gravity, strength and force, the sports computer comes up with the answers.

The computer also lets athletes see what they're doing wrong. It can make a true-to-life picture of the player appear on a TV screen. This lets an athlete see mistakes that he would miss in real life. And once the athlete spots the mistakes, it becomes easier to start practicing new and better ways of performing.

Of course, a computer can't turn just any person into an Olympic champion. But it can help talented people perform better. Before Al Oerter came to the Coto Research Center, his farthest discus throw in competition was 212 feet (64 m). But with the help of computers, other new training techniques and hard work, he threw it nine feet (2.7 m) farther than ever before!



Above: Dr. Ariel uses machines to collect information about an athlete's strength, rate of breathing and heart beat.
Left: Stick figures on a computer screen help athletes to take a look at how they perform. This one shows marathon racer Bill Rodgers jogging.

Music Computer

A 12-foot-tall copper cone slides out on ➤➤

stage. It is surrounded by bright lights and smoke. Moments later, sounds from an entire orchestra fill the room. The audience hears trumpets, harps, violins and drums. But no one is in sight. Then the cone's top comes down. Inside is the Iceberg Machine—and its inventor, Michael Iceberg.

Michael is sitting in the middle of this most unusual musical instrument. He is surrounded by three computers, six keyboards and dozens of buttons. This machine produces all kinds of musical sounds plus an assortment of whirs and bleeps. There are even knobs Michael can press to get animal sounds, chimes and human voices.

The Iceberg Machine contains three computers. Two control the synthesizers (SIN-thi-sizers). They are modern musical instruments that can stretch or bend notes to make unusual sounding music. The third computer is in charge of the drums.

Michael says it took him 13 years to make his Iceberg Machine. He began with 16 different musical instruments. Michael played each of these instruments himself. Then he taped their sounds and stored each note separately in the machine's computer files.

The computers help Michael to play every instrument in his orchestra and to serve as the conductor, too. He can play everything from classical music to rock 'n' roll. By putting notes together in different ways, he produces millions of different sounds. He has to decide which instruments to use, when to use them and how to blend all the sounds together. He'll take a note from the violin, then a note from the flute and add a note from the drums. The result is music to your ears!

Zoo Computer

You know that zoos are fun places to visit. But they have a serious purpose, too. Zoos can help to protect animals, especially those kinds which are in danger of dying off. One zoo that is very active in saving endangered animals is the Minnesota Zoo, near Minneapolis. There, a special computer called ISIS keeps track of 90,000 animals from 150 different zoos in North America and Europe.

The Minnesota Zoo is particularly concerned

about saving the Mongolian wild horse. None of these short-legged animals live in the wild in their Asian homeland any longer. But about 350 live in zoos around the world. It is up to the Minnesota Zoo and other zoos to see that these animals—also called Przewalski's (prez-WALL-skis) horse—survive.

You might think that 350 animals would be enough to guarantee the group's future. But these horses have a special problem. They're all related to each other. All the Przewalski's horses living today are descendants of 12 ancestors who were captured many years ago.

So zoo officials must be careful about the problem of *in-breeding*. That is what happens when closely related animals mate and have babies. These babies are more likely to be sick or weak. Some of their offspring might even die.

The ISIS computer helps the Minnesota Zoo to keep track of each horse and how it is related to all the others. With its help, zoos can plan ahead and select the best mate for each animal. So far, the computer is doing a super job of helping to save Przewalski's horses.

Above: Michael gives musical performances all across the country with his Iceberg Machine.
Left: As Michael Iceberg plays his Iceberg Machine, it sounds like a whole orchestra. Three computers help him to create unusual sounds.
Right: This mare and her colt are Asian horses called Przewalski's horses. A computer is being used to help these rare animals survive.

Any Questions?

Why are evergreens always green?

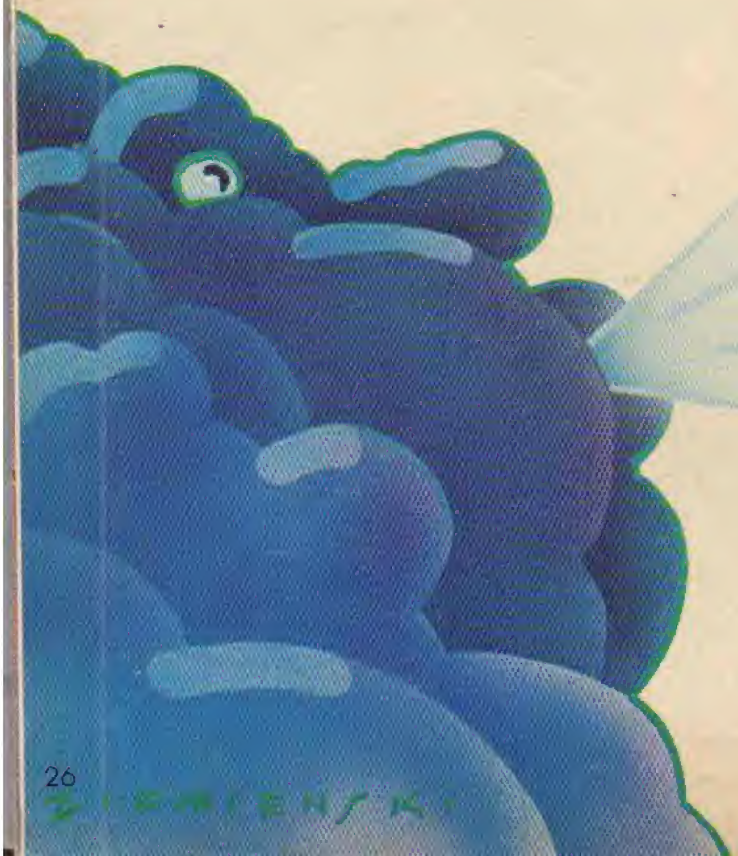
Most trees are green during spring and summer. In fall, the leaves turn colors. Then they drop off. But certain trees, like pines and spruces, stay green all year round.

The leaves that change color and drop off do so for good reason. These kinds of leaves are not built to stand up to icy winds and freezing cold temperatures. In self-defense, the tree's leaves change color, dry out and die. Once the harsh winter is over, the tree grows a complete new set of leaves.

Evergreens, however, are designed to stand up to severe weather. Their waxy, needle-like leaves hold their water and so do not dry out. These sturdy little leaves can also survive blasts of winter winds.

Most evergreens keep their leaves all year round. Many of them keep their leaves for several years. And they always grow new leaves before shedding their old ones. Since they look green all the time, they're called evergreens!

Question sent in by Brittany Faremouth, Detroit, MI.



Where does wind come from?

You could almost say that wind comes from the sun. Wind is nothing but air in motion. It's the sun that gets things moving.

As an example, think of a beach. The sun shines down on the sand and makes the air over the land very warm. Hot air rises. So the warm air is not pressing on the earth as much. In other words, the air pressure is lower.

Meanwhile, the air over the ocean is not warming up as fast. This cooler air is heavier than the warm air. That means the air pressure is higher over the water.

The atmosphere tries to balance out these different air pressures. After the warm air rises, the cooler air over the water moves in to take its place. It's that air movement which is called wind.

Weather forecasters often talk about highs and lows. These huge masses of air have different pressures. That is why, when one moves in to replace another, the wind often blows.

Question sent in by Jennifer Capellen, Laramie, WY.

Do you have a question that no one seems able to answer? Why not ask us? Send your question, along with your name, address, and age, to:

Any Questions?
3-2-1 CONTACT
P.O. Box 599
Ridgefield, NJ 07657

Who invented the hot-air balloon?

If you've ever seen smoke floating in the air, you know that it rises. The inventors of the hot-air balloon noticed the same thing nearly 200 years ago. They were two Frenchmen, named Joseph and Étienne Montgolfier.

The Montgolfiers filled small paper bags with smoke and watched them rise toward the ceiling. The brothers soon realized that the hot air in the smoke —not the smoke itself—was doing all the work. Since warm air is lighter than cool air, it rises. In a balloon, the air is heated by a flame and rises to the top. Then, more cool air at the bottom heats up and rises. Soon the balloon is full of hot air. It starts to float.

After more experiments, the Montgolfiers built larger balloons and launched them. Finally, on September 18, 1783, they sent up their first passengers—a duck, a rooster and a sheep. The trip was a success! Soon after, people were floating through the sky in hot-air balloons.

Question sent in by Nicole Meddaugh, Aura, MI.

Why do you get a pain in your side when you run?

Suppose you're running, when—OUCH!—there's a sharp pain in your side. The pain is known as a *stitch*.

A muscle under your lungs called the *diaphragm* (DIE-uh-fram) might be one cause of a stitch. The diaphragm's job is to move up and down, helping to push air in and out of your lungs. When you run, you breathe harder than usual. Your diaphragm doesn't get enough oxygen, and it gets tired. That's when your side starts to hurt. The nerves that control your diaphragm start near your neck. So you might feel a pain in your neck or shoulder, too. You also can get a stitch by eating too much. As you run, gas builds up in your intestines and causes pain.

The best thing to do when you get a stitch is to slow down or rest. Begin to breathe deeply. When you exhale, close your lips a little and breathe out —slowly. How about grunting right after you exhale? It sounds funny, but it might work.

Question sent in by Jennifer Sekelsky, Milford, CT.

Nerves

by Kim Solworth Merlino

Do your friends get on your nerves once in a while? Do you get on their nerves? Actually, nerves are threadlike parts of your body. They are so thin that no one, not even an ant, could *get* on them!

Nerves carry messages to the brain from the senses. Your brain, of course, is the big boss of your body. But it has a problem. Locked up inside your head, it needs information about what's happening in the rest of your body and in the outside world. That's where nerves come in. They send *billions* of messages a day to the brain. The brain stays informed about conditions in your body and all around you. That information helps your brain make important decisions.

Nerves are hard at work even when you're sound asleep. Every part inside you, like your heart and kidneys, sends messages to the brain. Many of the jobs of your nerves take place without you ever being aware of the messages. You don't have to think about your heart to keep it beating, for example. Lucky for you! Or else you wouldn't get any sleep!

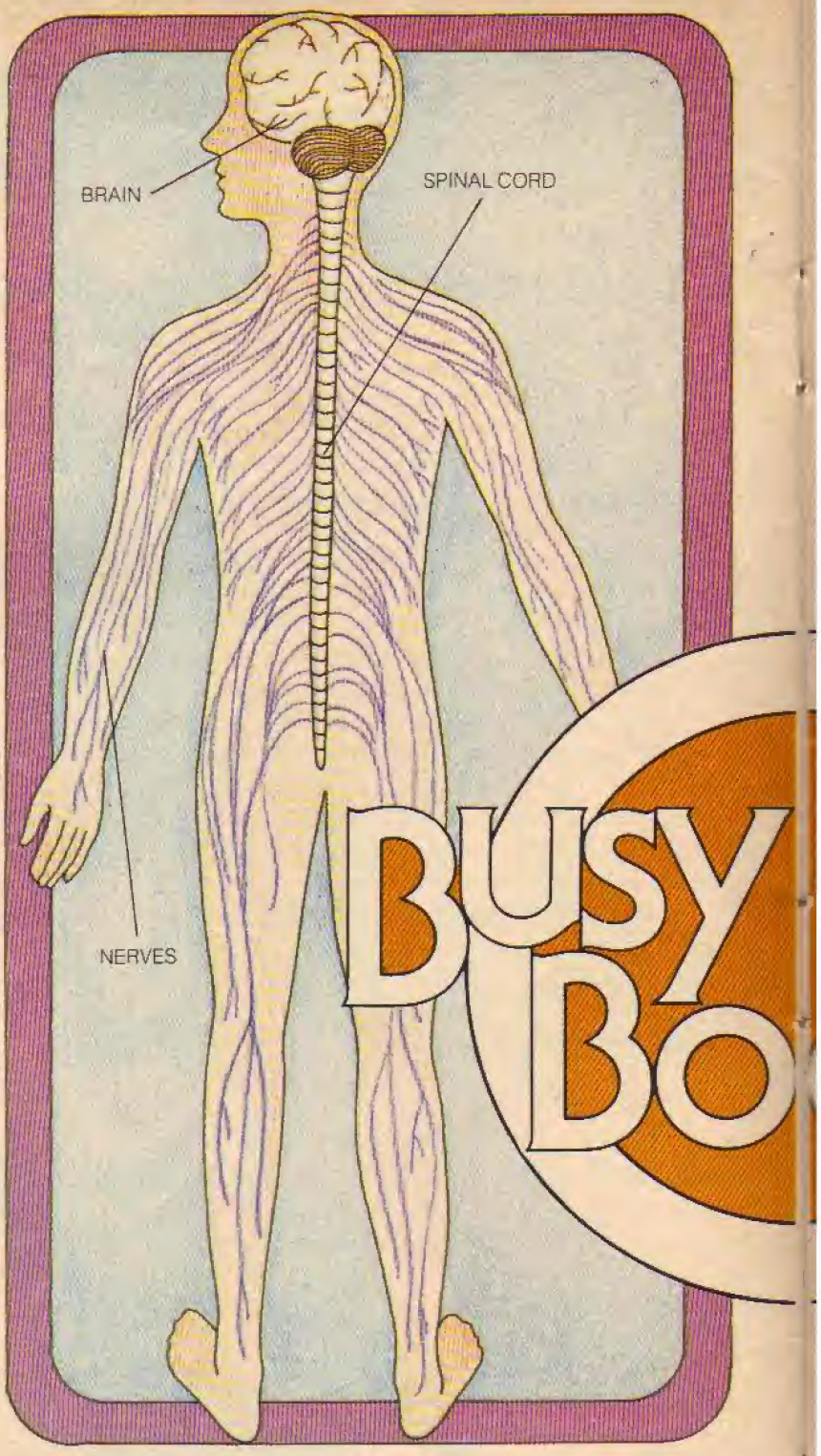
Meet Your Nerves

Feel your head. Your hard skull is a protective container for your brain. The brain is made of billions of nerves, tightly packed. Reach around to the center of your back. Feel your spine? Inside this row of bones is a passageway. That's where your *spinal cord* is located. This thick bundle of nerves connects your brain with the rest of the body.

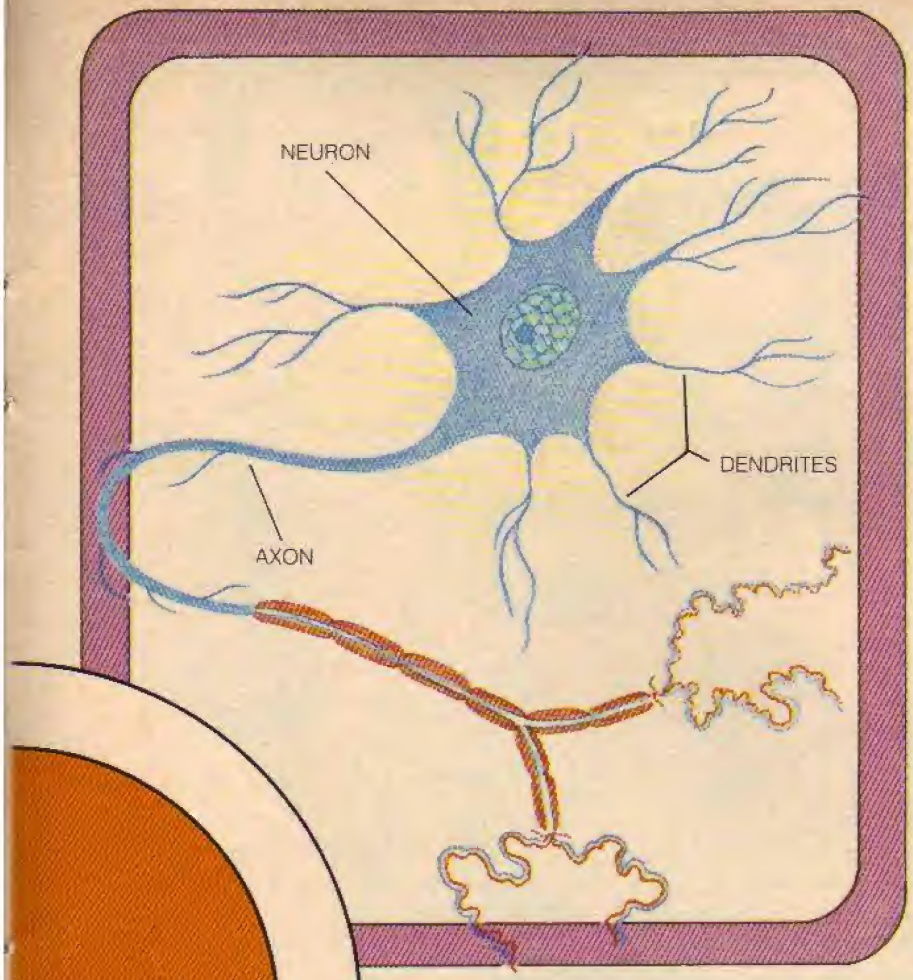
Branching out along the spinal cord are pairs of nerves—31, to be exact. All day long, messages travel along the nerves to the spinal cord and up to your brain. Some parts of the body are so close to the brain that they do not send messages by way of the spinal cord. Your eyes, ears, nose and mouth all have nerves that carry information directly to the brain.

The brain stores the information and then makes decisions. It sends its own messages out along nerves. It directs organs, like the heart or stomach, to adjust their activities.

Suppose you are jogging around the block.



Coming around the first turn, your leg muscles begin to send messages to the brain. They are not getting enough oxygen to keep up the pace. The brain sends a message to the heart to beat faster. Once this happens, you start to breathe faster, too. Soon there is oxygen-rich blood on the way to your legs. Luckily, you didn't have to think about doing all that while you were running. You might have missed seeing a big hole and fallen in!



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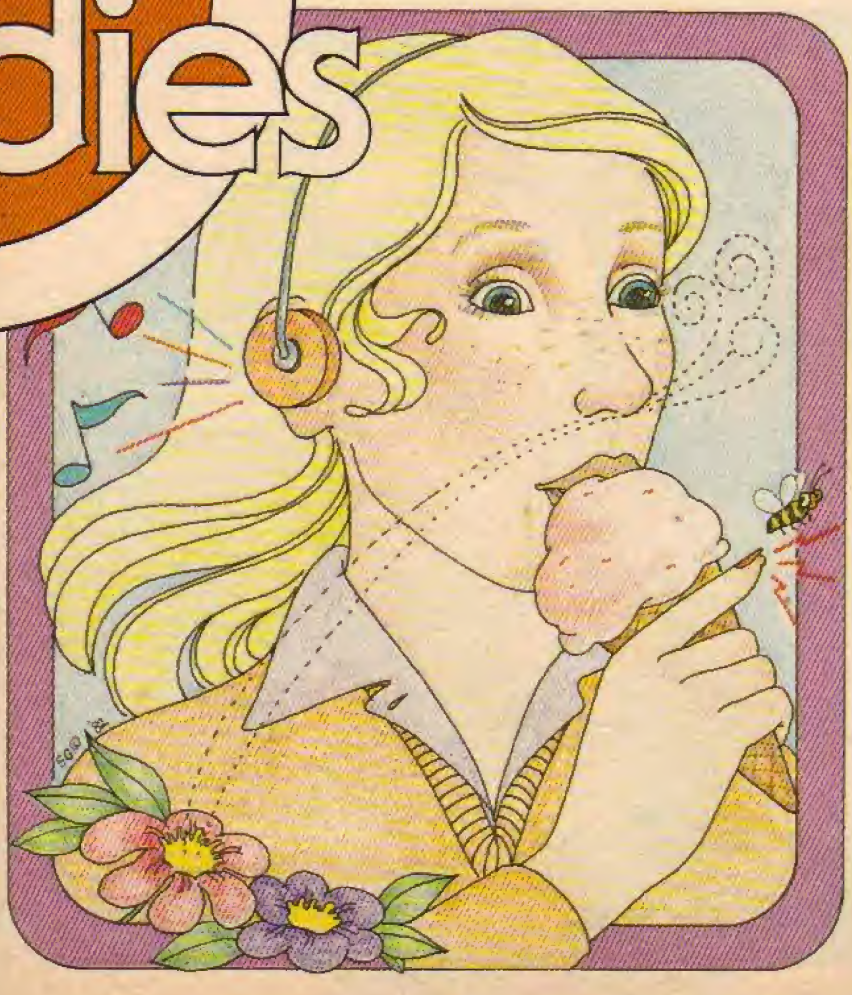


Imagine the Nerve

Your entire *nervous system*, the brain, spinal cord and nerves, is made up of tiny nerve cells. There are about 13 billion nerve cells, or *neurons*, inside you. Each tiny neuron has a roundish body, many short branches and one longer branch. The shorter branches are called *dendrites*. They receive messages from other cells. The longer branch is called the *axon*. It sends the message on to neurons in another part of the body. The cell body is very tiny, but the axon branch can be very long. Your longest axon reaches from your big toe all the way to the brain! Messages travel very fast, about 300 miles (480 km) per second! When someone steps on your toe, it doesn't take long for you to get the message!

There are several kinds of neurons. Each has a different job to do. Messages travel *to* the brain along *sensory* neurons. *Motor* neurons carry messages *from* the brain to other parts of the body. Connecting sensory and motor neurons are "switchboard" neurons. These *association* neurons get the messages and make decisions about what should be done. As you might suspect, your brain is mostly made of a giant mass of association neurons.

A Sensitive Subject

Your eyes, ears, nose, tongue and skin are information-gathering organs. Each sense organ has tiny nerve endings in it called *receptors*. In your eye, for example, receptors are at the back of the eyeball. Eye receptors are sensitive to light and colors. The brain understands that all messages from the eye are about lights or colors.

Your skin has several kinds of receptors. There are five kinds of touches that can be relayed to the brain. That's why a light tickle feels different from heat or a sharp pain. You might ignore the ticklish feeling, but you will pull away the instant a pin pricks your finger.

Ouch! That's Not Funny!

Did you ever bang your elbow and get an aching, trembling pain up and down your arm? You hit your funny bone! The funny bone is not a bone at all, but a long nerve. It runs from your fingertips up your arm. The nerve is well protected everywhere in your arm except that one spot. When you hit your elbow, you squeezed the nerve against a bone in your arm. The pressure caused the pain.

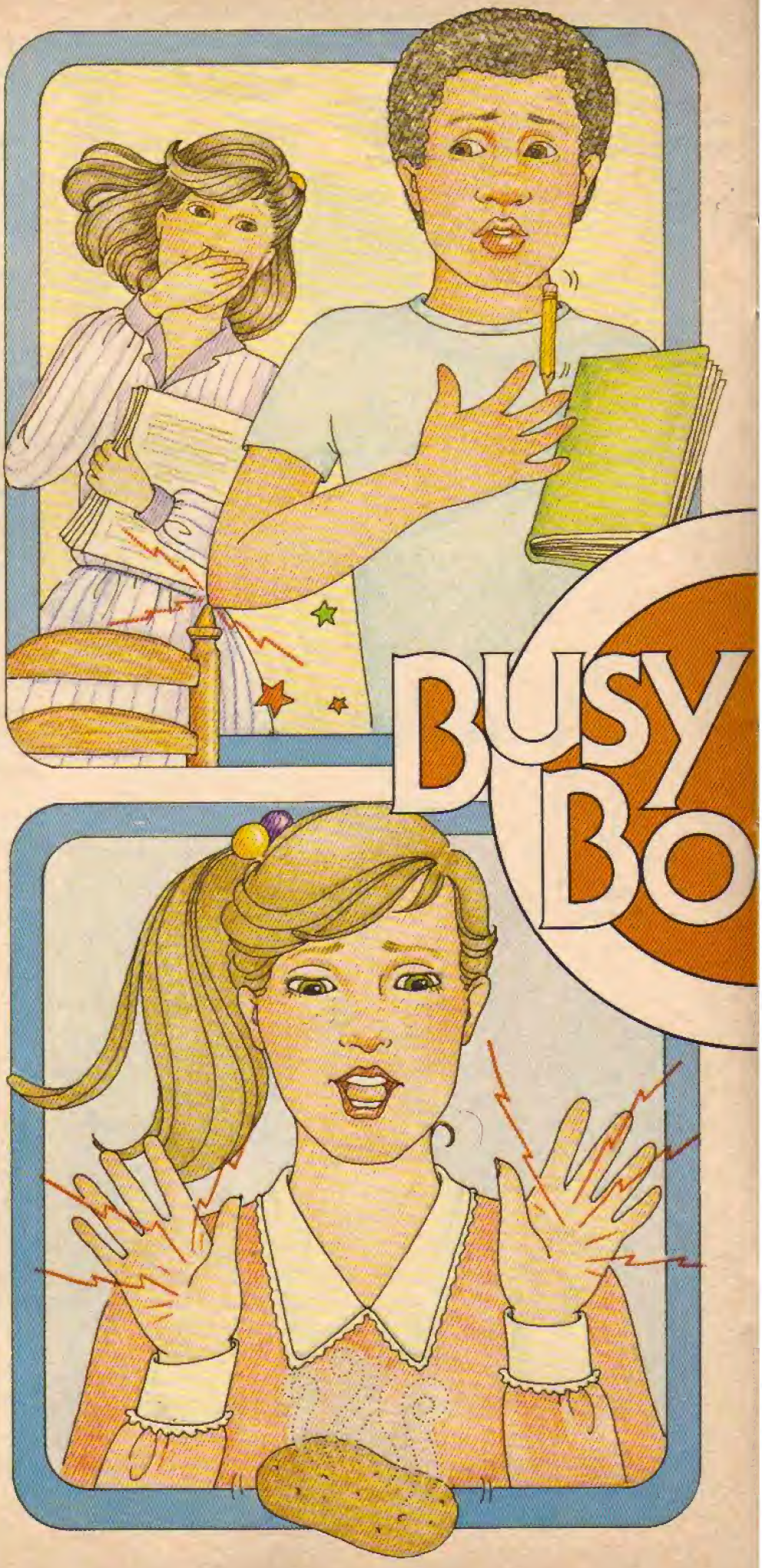
How did it get the name "funny bone"? Could it be because the name of the bone next to the nerve is the *humerus*? That sounds the same as the word *humorous*, which means funny. But who's laughing?

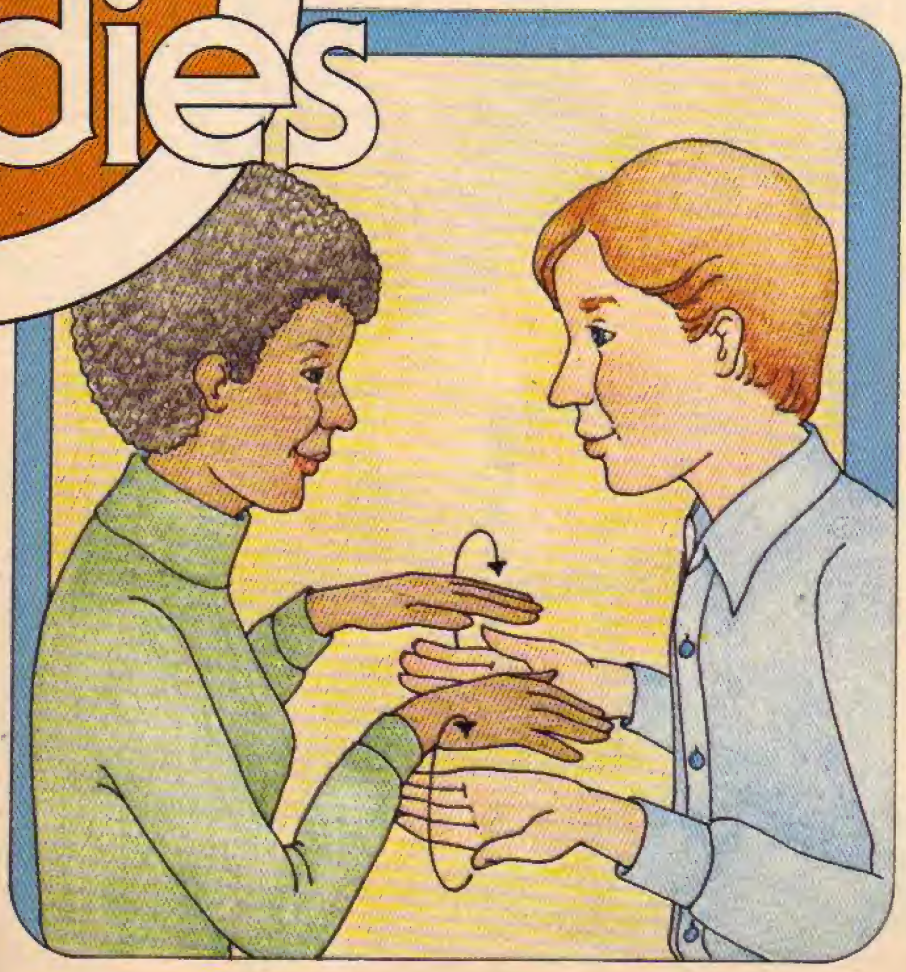
Hot Potato

Did you ever grab something that you thought was cold . . . but it wasn't? Before you knew it, the hot potato was on the floor. Only a couple of seconds later did you realize what had happened. Then your hand began to hurt. Why did you drop it before you felt the heat? Your body had a *reflex action*.

Reflexes are actions that your nervous system does very fast. They are important because sometimes a little extra speed can save your life. How can reflexes be faster than thinking? Because the brain is not involved. The hot message travels from your hand to the spinal cord. Decision-making neurons in the spinal cord instantly send a signal back to your hand muscles to pull away.

Reflexes save time because the message doesn't have to travel all the way to the brain. Other examples of reflex actions are sneezing and blinking. Doctors test the speed of your reflexes. When they tap you below the knee with a rubber hammer, your leg springs forward. That's a reflex action.





Nerve Overload

Here's a little activity that will send a very strange nerve message to your brain. Stand in a doorway, with your arms at your sides. Press your arms as hard as you can against the walls for 30 seconds. Then relax your arms and take a step forward. As you do, your arms float up in the air. What happened? Your arm muscles are still getting the message to rise, even though you thought you stopped sending it.

People who break their arms and wear casts for several weeks notice the same kind of thing. When a heavy plaster cast is cut off, the arm floats up in the air. It takes a few seconds for the nerves and muscles to adjust to the new situation.

Reflex Game

Stand facing a friend with your hands held out and palms up. Tell your friend to place her hands on yours so that the palms are touching. Now the game begins. You try to slap the backs of your friend's hands before she pulls away. She tries to pull her hands in time. Try to trick her nerves into sending the message that you are about to slap. If she flinches, or pulls away, you get a free slap. If you really do try to slap, but miss, switch hand positions. It's her turn to do the slapping!

When it's your turn, you realize that it's not so easy to stop your hands from flinching. Your nerves are doing their job. Your eyes see the danger coming, and the brain sends a message to the hand to pull away. You really have to concentrate not to flinch. As you play the game, you will get better at sensing your partner's signals. Pretty soon you can tell when she is faking . . . oops! You flinched!

List of the Month

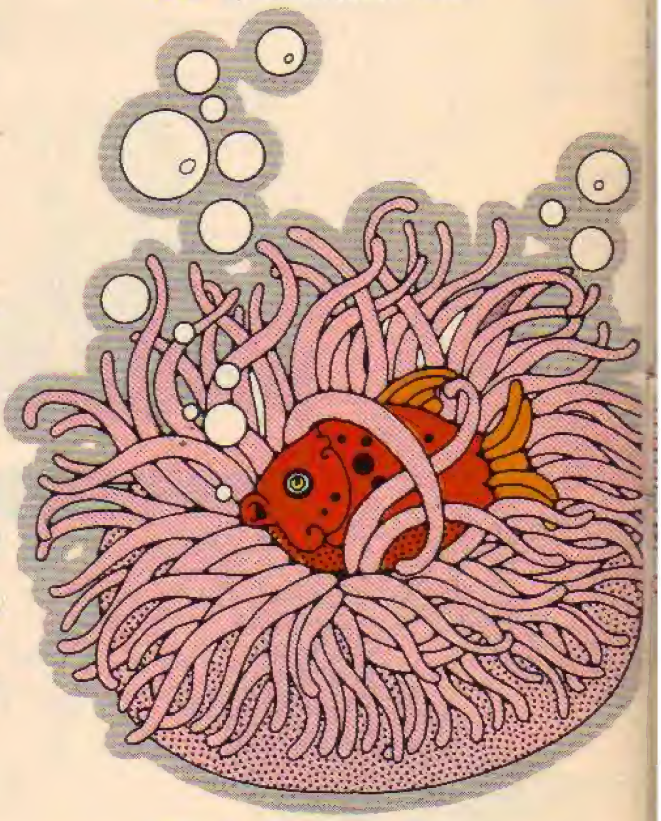
Creature Features

by Rebecca Herman

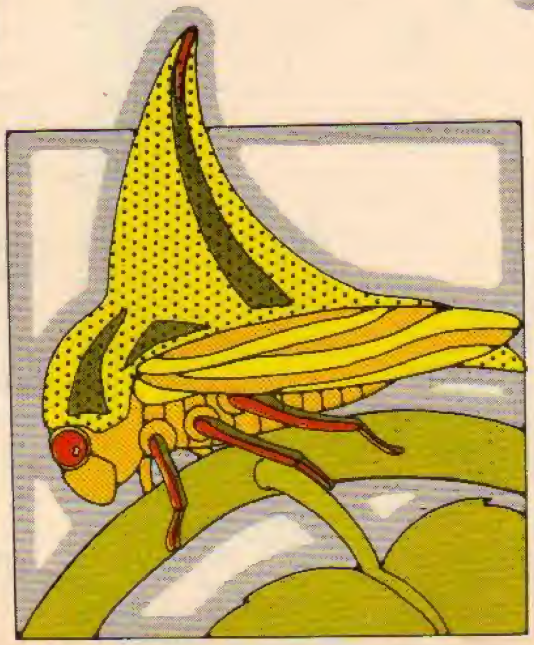
If you liked the monsters on this month's poster, read on. Here are eight real-life weird animals.

All in the Family Believe it or not, there's an animal related to apes and people that doesn't look like either of them. This tiny primate is called a tarsier (TAR-see-er). About the size of a rat, the tarsier often uses its tail as a third leg. As it swings through the trees, its tail helps it to balance and hang on. The tarsier spends its days sleeping and its nights awake. Its huge eyes help the creature see in the dark.

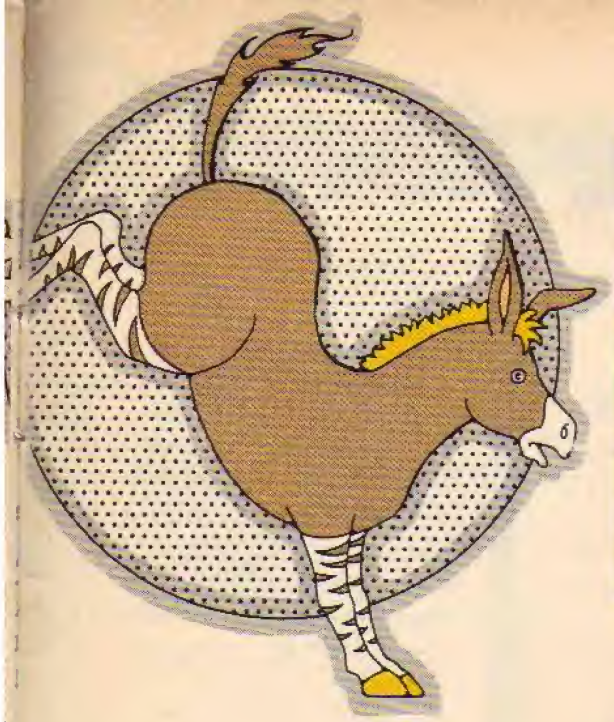
Striped Donkey What do you get when you cross a donkey with a zebra? A donkey zebroid! People in Africa hoped that an offspring of a donkey and a zebra would combine the best traits of both. An animal with the donkey's tameness and the zebra's ability to fight disease would be the perfect farm helper. But the donkey zebroid was neither tame nor healthy enough. Better luck next time!



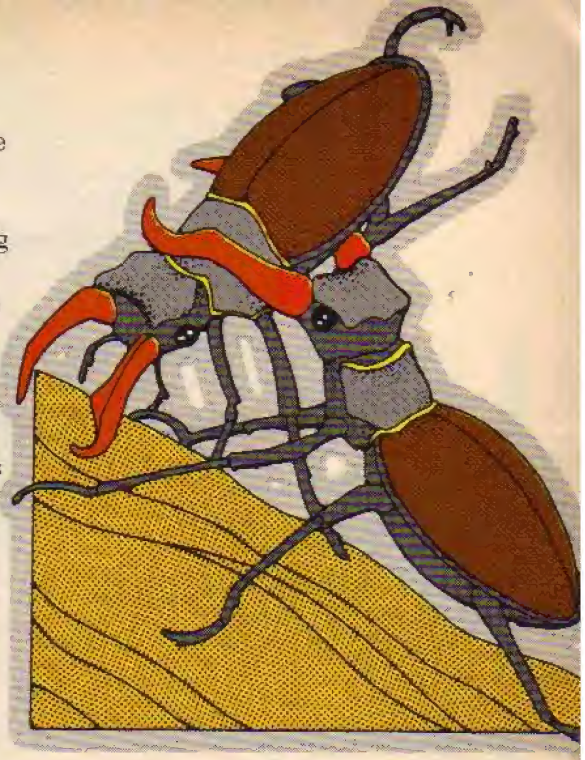
Hop to It! The treehopper does lots of hopping, as you might guess from its name. Although it can fly, the tiny insect usually jumps from leaf to leaf. The strangest thing about this bug isn't how it travels but how it rests. When the treehopper stays still, it looks like a thorn or twig. Because it disguises itself, the leaf-hopping bug can stay safe from animals which might eat it.



Dig It! Moles are pesky animals that dig up your yard, right? Well, there's a mole that actually swims and catches fish, too. The star-nosed mole lives in swamps or wet ground. There it digs for worms and insects to eat. The tunnels it digs often lead to a stream or pond, where it hunts tiny fish. To help look for the fish, the mole uses the 22 tentacles around its nose. Shaped like a star, the tentacles give the mole its name.

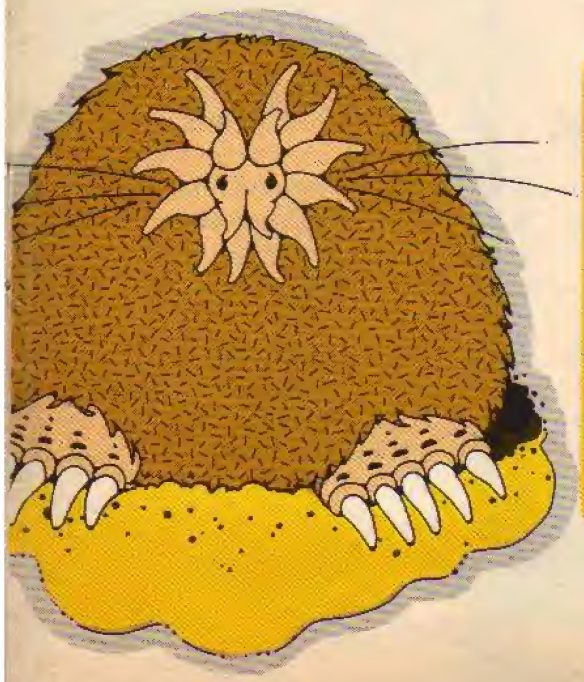


Beetle Battle The stag beetle got its name because its horns look like those of a male deer, or *stag*. Male stag beetles use their horns to battle for a mate. When two stag beetles meet, they use their pincers to push each other around. Sometimes they lift each other off the ground. The beetle that gets flipped on his back is the loser. While he tries to turn over, the champ walks off with the female.

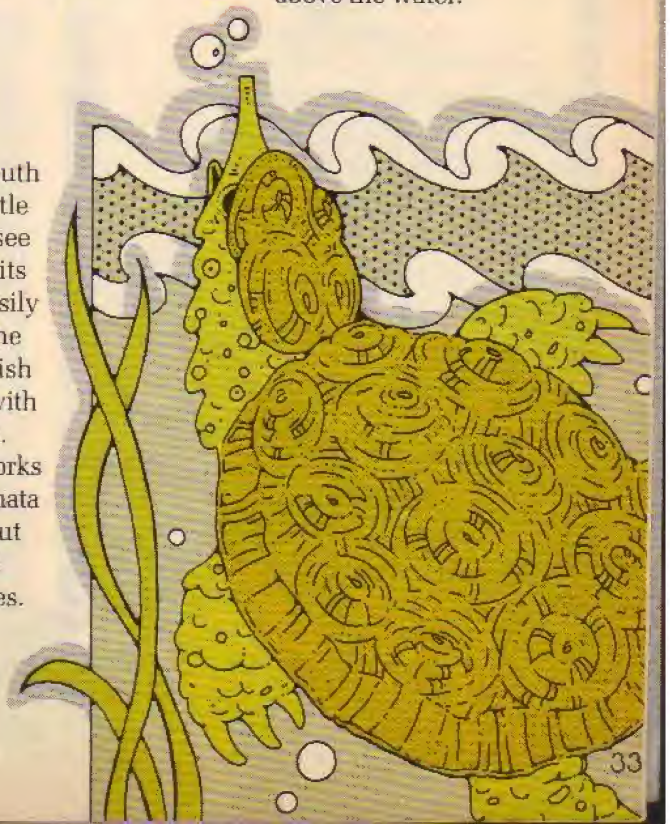


Poisonous Points The anemone (un-NEM-uh-nee) looks like an ocean plant, but it's an animal. Around its mouth are tentacles, with tiny, poisonous needles. When a fish brushes against the tentacles, the anemone injects the animal with venom. Then it draws the meal into its mouth. When the anemone isn't eating it closes its mouth around the tentacles. Then it looks like a stone on the sea floor.

Giant Rodent Most rodents are pretty small. But one is a giant. The capybara (cap-ih-BAR-uh) of South America is 3 feet (1 m) long and weighs 90 pounds (40 kg). It looks like a giant guinea pig. A happy capybara makes whistling and clicking noises. When disturbed, it runs away, sometimes into the water. There, it hides among floating plants. To breathe, it keeps its nostrils above the water.



What's a Mata? The South American matamata turtle is almost impossible to see underwater. Because of its green color, it can hide easily from the fish it hunts. The matamata captures the fish by vacuuming them up with its suction pump mouth. The turtle's long nose works like a snorkel. The matamata keeps its nose sticking out of the water. That way, it can breathe while it hides.



Reviews &

Here are some books to read and things to do and see after reading this issue of 3-2-1 CONTACT.

An Air-Raising Activity

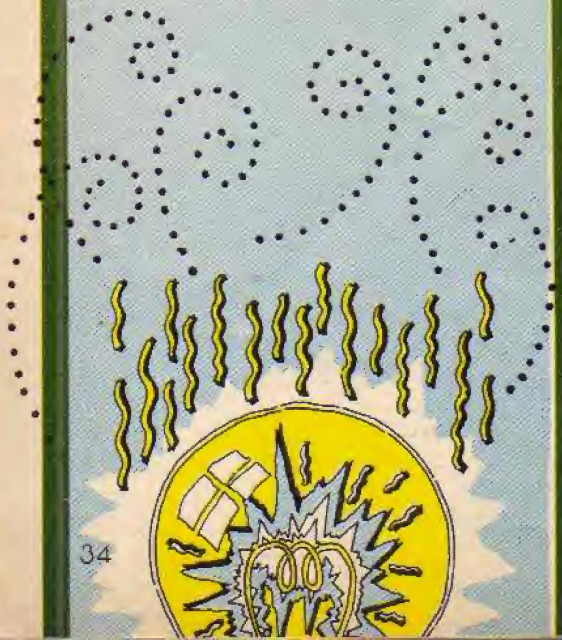
In *Any Questions?* you learned a bit about how winds form. Here's an activity that helps explain it:

1. Sprinkle a little talcum powder on a cloth. Shake the powder over an unlit light bulb. What happens?

2. Now turn on the light bulb and let it heat up. Put some more powder on the cloth and shake it off over the bulb. What happens now?

Before you turn the bulb on, the powder drifts down through the air slowly. When the bulb becomes hot, it warms the air above it. The warm air rises and takes the powder with it. As the warm air rises, cooler air falls to take its place. A moving cycle of air is created.

The same thing happens outside when the sun heats the ground. Warm air rises, and cool air flows in to take its place. That's wind.



Giant Redwoods

This month's *Earth Works* takes a look at leaves. Of course, where there are leaves there are also trees.

Some of the most amazing trees are the redwoods of California. They are the world's tallest. Some of them stand higher than a 30-story building.

Our Redwood Heritage is a free color booklet about the redwood forests. It has maps showing where the forests are, and also some good pictures of these living giants. To get a copy, write to:

California Redwood Association
One Lombard Street
San Francisco, CA 94111

Time Tunnel Museum

This review was sent in by Nina Hobbs, Hood River, OR.

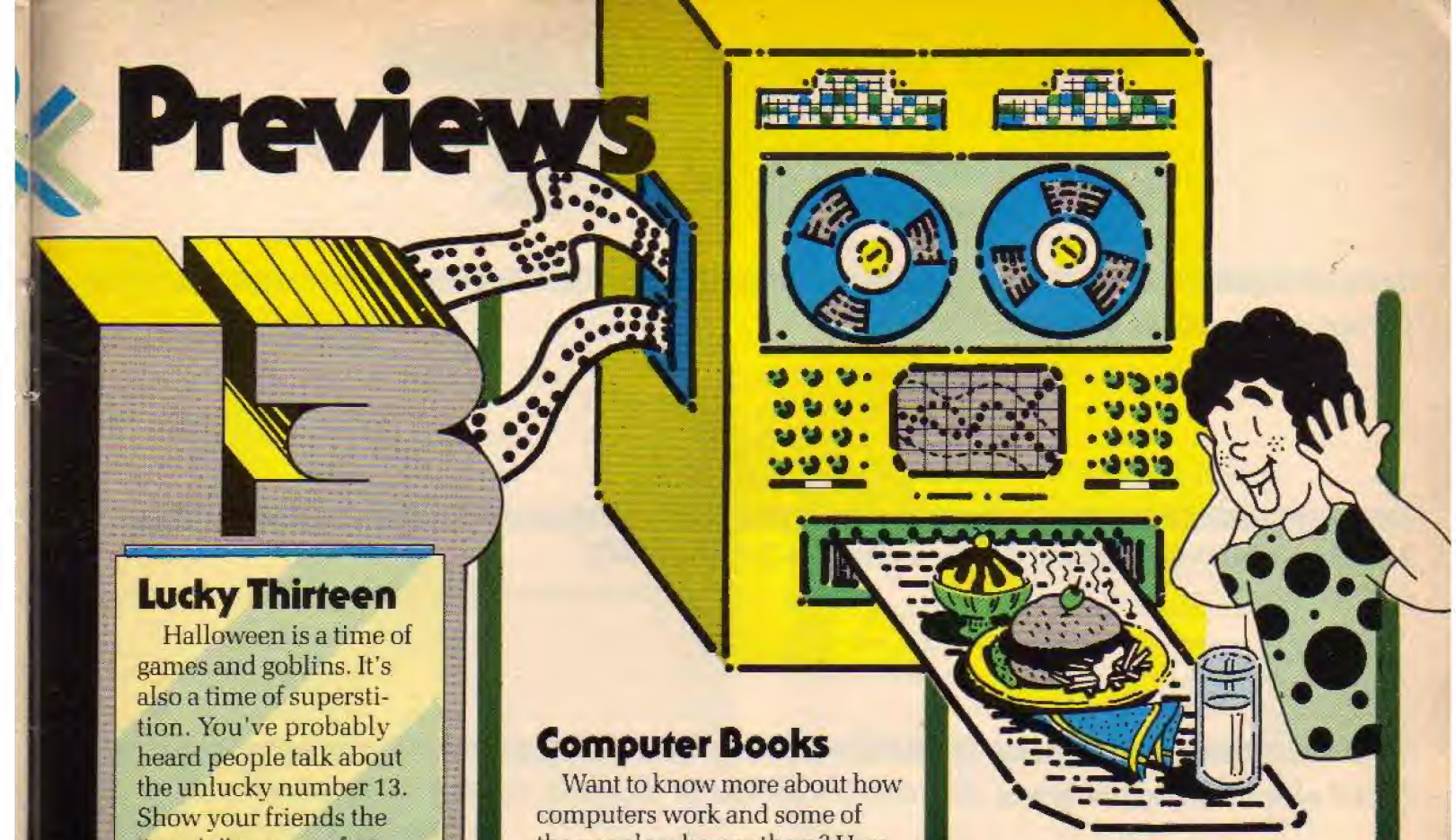
The Children's Museum in Portland, Oregon, was an exciting adventure. I went through a time tunnel, and saw all sorts of things out of the past. I also got to make pottery and take it home. There was even a playroom, too, where we could build and make things. Upstairs we saw animal furs and a rock and shell collection. When we entered, an enormous tiger looked like he would pounce on us, but he wasn't real, and didn't have teeth. It sure was an exciting day.

Have you visited a science museum recently? Why not write a short, 100-word review and send it to us? If we print it,

you'll get a CONTACT T-shirt. Send your review, name, address and T-shirt size to:

3–2–1 CONTACT:
Museum Review
P.O. Box 599
Ridgefield, NJ 07657

Previews



Lucky Thirteen

Halloween is a time of games and goblins. It's also a time of superstition. You've probably heard people talk about the unlucky number 13. Show your friends the "magic" powers of 13 with this number trick. To do this trick, you will need a pencil and paper.

1. First, pick a number.
2. Add 11 to the number you picked.
3. Multiply the answer by 6.
4. Subtract 3 from the answer.
5. Divide what you got by 3.
6. Subtract the original number from 6. Add what you get to the answer from #5.
7. Subtract one more than the original number you picked from the answer in #6.
8. Divide that answer by 2. No matter which number you pick, the answer is always 13!

Computer Books

Want to know more about how computers work and some of the people who use them? Here are some books to look for at a bookstore or library.

Meet the Computer Did you know that the glass of milk you drank for lunch probably got to you with the help of computers? If you can't imagine how that could be true, read this book by Bruce Lewis. It's full of information on how computers affect your life every day. The book is published by Dodd, Mead & Company.

What Can She Be? A Computer Scientist If you've ever wondered what a career in computers is like, this book is for you. You'll find out what kinds of skills are needed for this kind of work. You'll also learn what different things people who work with computers do. *What Can She Be?* is written by Gloria and Esther Goldreich and published by Lothrop, Lee & Shepard.

Exploring With Computers Gary G. Bitter's book not only tells about modern computers—it also tells about computers of the past. Plus, there is a special activity section to help you better understand how a computer works. Julian Messner is the publisher.

3-2-1 Contest?

By now, you're probably wondering where this month's T-shirt contest is. We didn't forget it. We just put it in a different place.

On page 36, you will find a list of questions. Fill them in

and send your answers to us. On December 1, 1982, we will pick ten letters from all those we receive. The kids who sent them in will get CONTACT T-shirts.

Contact Us!

Win a T-shirt! Here's your chance to help us plan future issues of 3-2-1 CONTACT and to win a T-shirt. All you have to do is fill out this questionnaire and mail it to us. We will pick 10 letters at random. The kids who sent us those letters will get CONTACT T-shirts. There are no wrong answers so try to be as honest as you can.

Send your completed questionnaire to:
Reader Poll
P.O. Box 599
Ridgefield, NJ 07657

1. First, tell us about yourself.

Name _____

Address _____

City _____ State _____ Zip _____

Age _____ Grade _____ T-shirt size _____ I am a boy ___ girl ___

2. Tell us what you thought of this month's 3-2-1 CONTACT.

My MOST favorite stories were:

(1) _____

(2) _____

(3) _____

My LEAST favorite stories were:

(1) _____

(2) _____

(3) _____

3. Tell us what you thought of this month's computer features. Mark your answers with an X.

	I liked it a lot	It was OK	I didn't like it
Cover puzzle	☐	☐	☐
Movie Magic from MAGI (pp. 4-7)	☐	☐	☐
Do It: Codes (p. 13)	☐	☐	☐
Electronic Artist (pp. 14-17)	☐	☐	☐
Halloween Board Game (pp. 18-19)	☐	☐	☐
Computers in Action (pp. 22-25)	☐	☐	☐

4. Okay. Now we want to know what you think of computers and video games.

	Yes	No
Does your family own a home computer?	☐	☐
Does your family own a home video game player?	☐	☐
Do you ever play arcade games?	☐	☐
Do you like electronic games?	☐	☐
Do you ever use a computer in school?	☐	☐

If you have ever used a computer, tell us what kinds of things you did with it.

_____

_____

_____

5. Hang on! You're almost done.

My favorite electronic games are:

(1) _____

(2) _____

(3) _____

6. At last! The final question.

Would you like to see more computer-type stories in CONTACT? Tell us what kind of stories you would like to see.

Yes ☐ No ☐

_____

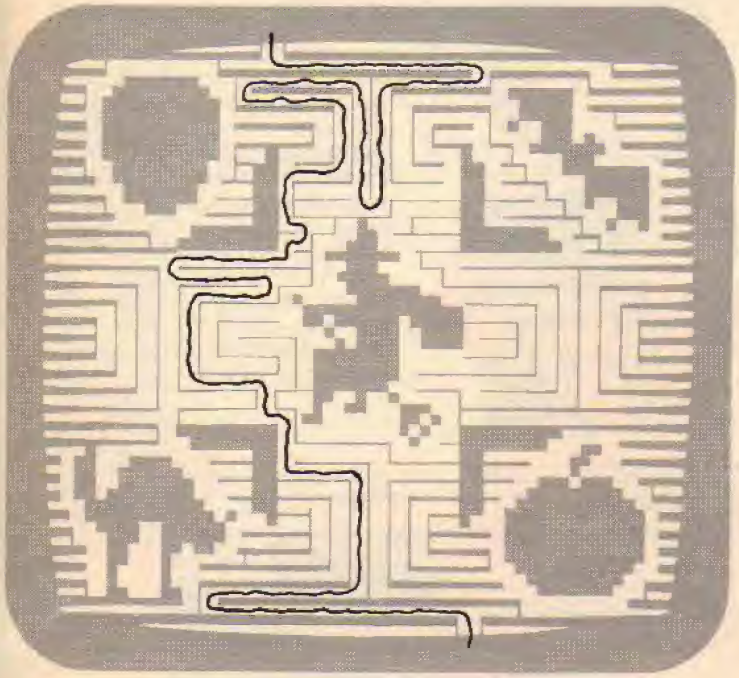
_____

_____

_____

Did It!

Maze (cover)



Code (page 13)

More than the dog.

We Want Mail! That's right, we want you to write to CONTACT. Do you have a question about our magazine or show? Or maybe you have a science story, an idea or a picture you'd like to send us. Perhaps we'll print your letter.

Write to:
3-2-1 CONTACT Letters
P.O. Box 599
Ridgefield, NJ 07657

Thank You!

Special thanks to Judy Casulli for writing this month's *Reviews & Previews* and to student interns Nancy Arnott, Carol Costello and Suzanne Martinucci for their help with this month's issue.

Contest Winners

Thanks for sending us your toothy creatures. Our favorites appear on the poster (pages 20-21). The winners are (from left to right): Laurie Gwin, Gales Ferry, CT; Rachel Tanabe, Seattle, WA; Leigh Salinas, Corpus Christi, TX; Cindy Rosenblum, Brooklyn, NY; Shirley Shah, DuBois, PA; Robert McGregor, Strathroy, Ontario, Canada; Pandora Beatty-Quilcene, WA; Danny Stoddard, Bethel, VT; Jason Sayat, Cambridge, OH; Eric Klick, Lebanaon, PA; Heidi Telfer, Anderson, IN; Joy Tobias, Darlington, PA; Ruth Corradi, Lyndhurst, OH; Bryan W. Reed, Colliers, WV; Christine Okonski, DuBois, PA; Andrea Bird, Holt, MI; Julie Meyers, Allentown, PA; Beth Fitzpatrick, Waterford, CT; Karen Brozek, Oxford, CT; Suzie Mandt, Thompson, ND; Catherine Paik, Johnson City, TN; Todd W. Anderson, Escondido, CA; Mark Bowen, Duluth, MN.

Credits

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Next Month!

Here's a sample of what you'll find in the next issue of 3-2-1 CONTACT:

What's for Dinner?

Find out what CONTACT readers eat and see how your meals compare.

Bloodhound Gang

Part one of the mysterious "Case of Trouble in Paradise."

Never Cry Wolf!

Wolves aren't so scary. Read about them and a new movie they're in.

Plus Factoids, a Poster, Mail and Much More!

Perfect gifts for Christmas

SESAME STREET MAGAZINE

Treat your favorite pre-schoolers to a year of fun-filled learning, with a gift subscription to Sesame Street Magazine.

Puzzles, cut-outs, games, A-B-C's, 1-2-3's . . . there's all the magic of the TV super-series in every colorful issue.

Big Bird and his delightful friends will bring dozens of playful surprises, 10 terrific times a year.

It's the entertaining education that Sesame Street does best!

ELECTRIC COMPANY MAGAZINE

Yes — there is a gift that's amusing, playful, absorbing AND educational for beginning and young readers. It's the Electric Company Magazine — as creatively entertaining as the TV show kids love. Give a fun-filled gift this Christmas: 10 colorful Electric Company issues that will fill the year with puzzles, posters, cut-outs, Spider-Man adventures, jokes... and sunny smiles.

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Yes, please send one year (10 issues) to the names below.
First subscription is $8.95*
. . . . each additional gift only $6.50*

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8FB31

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MAIL TO: THE ELECTRIC COMPANY
200 Watt Street, P.O. Box 2922, Boulder, Co. 80322

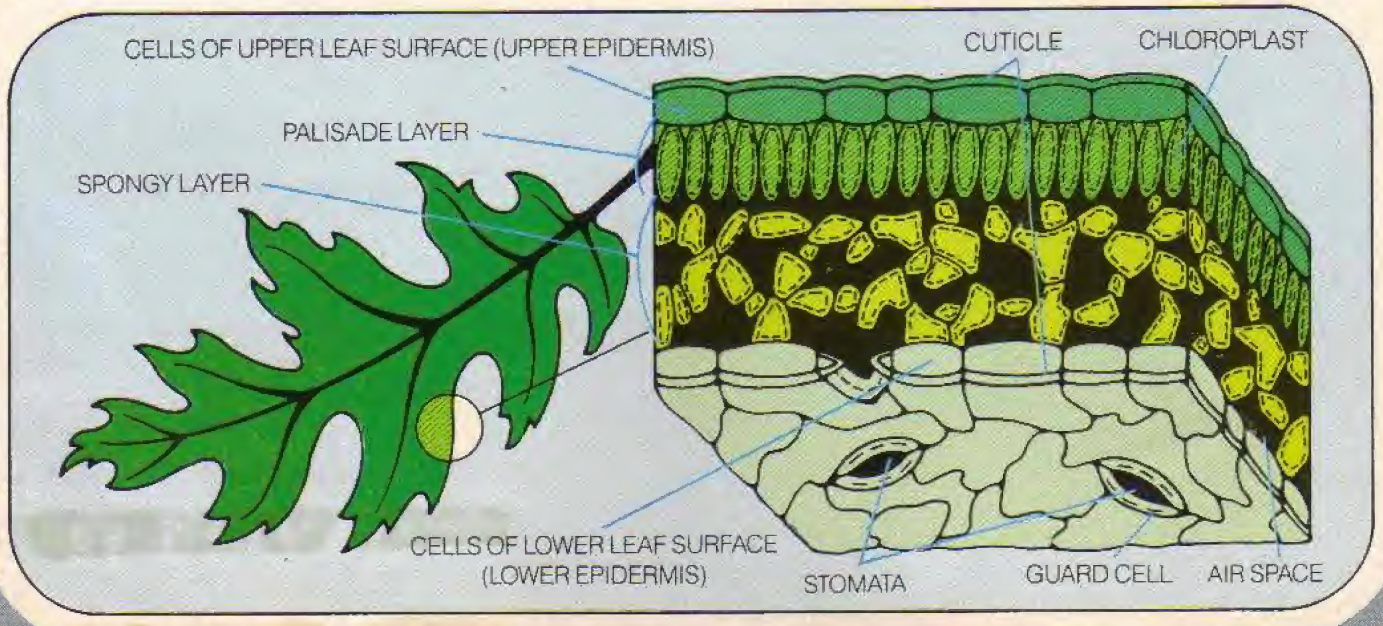
Earthfacts: Leaves

Each month CONTACT will bring you another *Earth Works*. Save these pages in a notebook. Soon you will have your own guide to the wonders of the planet Earth.

EarthWorks

- Plants make food in their leaves during *photosynthesis*. Using water from soil, carbon dioxide from the air and energy from the sun, they produce sugar and starch.
- In mid-summer, the leaves of a full-grown sugar maple tree can make 3,000 pounds (1,350 kg) of food.
- All life on earth depends on this food made by the leaves of plants. You can get it directly by eating leaves like lettuce and spinach. Or you can get it by eating other parts of the plant where the food is stored: fruits like apples, stems like asparagus or roots like carrots. Even meat can be traced to leaves since most animals used for meat eat plants.
- Most leaves are from 1 to 12 inches (2.5-30 cm) in size. The world's largest leaves are on Africa's raffia palm. They're 65 feet (29 m) long. Asparagus has some of the smallest leaves. You need a magnifying glass to see them.
- All through spring and summer most of a leaf's color is from a green substance called chlorophyll (KLOR-a-fill). But green leaves also contain a yellow material called xanthophyll (ZAN-tha-fill) and an orange material called carotene (KARE-a-teen).
- *Deciduous* trees lose their leaves in fall. *Evergreen* trees have leaves all year round.
- A substance called anthocyanin (an-tho-SY-a-nin) forms in some leaves in fall, turning them red and purple. Some of the brightest reds can be found on sugar maple and sweet gum trees. This is especially true when fall days are cool, dry and sunny.
- Many leaves have special features that protect them from being picked or eaten. If you touch poison ivy, oil on its leaves will give you a rash. Leaves of plants like rhubarb are poisonous. Sharp hairs on nettle leaves sting when touched.
- You use leaves often in daily life. You probably eat leaves like cabbage. Your food is seasoned with spice leaves like thyme and sage. Chewing gum is flavored with peppermint and spearmint leaves. And if you drink tea, you're drinking the juice of tea leaves.

Below: Inside a leaf: *Stomata* are holes that let water vapor and other gases in and out. Each is opened and closed by a *guard cell*. Food is made in *chloroplasts* of the *palisade layer* and stored in the *spongy layer*.



EarthWorks

Leaves

A few weeks ago these leaves were bright green. With their surfaces pointed at the sky, they did their job of collecting sunlight. That light was used as fuel. The leaves used the light to make the food that all plants, animals and people need to live.

Now that it's fall, these leaves have stopped producing food. The cold air has made the green substance inside them, called chlorophyll, break down and disappear. Now the yellow and orange colors that were hidden all summer in the leaves can show through.

To find out more about leaves of all colors turn to page 39.

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